WONDERS OF LAND AND SEA

Underground Scenery

There is little on the surface of the globe to correspond to the wonderful scenery of the nether-world. In certain caves ice assumes fantastic and ravishing forms. The ice itself forms pendants like stalactites, where water exudes from the roof, and the continual drip causes stalagmites of ice which tower in vast columns and pyramids almost to the roof

WONDERS OF LAND AND SEA

EDITED BY

GRAEME WILLIAMS, F.R.G.S.

Fellow of the Royal Historical, the Geological, and the Zoological Societies

With an Introduction by

SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

And Contributions by Many other Eminent Specialists

★ ★ ★

LONDON:

THE WAVERLEY BOOK COMPANY, LTD

96 FARRINGDON STREET, E.C.4.

New and Revised Edition

CONTENTS

SECTION I.—ON THE LAND

(a) *NATURAL*

(b) *ARTIFICIAL*

SECTION II.—IN THE UNDERWORLD

(a) *NATURAL*

(b) *ARTIFICIAL*

Contents

SECTION III.—ON THE SEA

(a) *NATURAL*

(b) *ARTIFICIAL*

SECTION IV.—IN THE DEPTHS

(a) *NATURAL*

(b) *ARTIFICIAL*

SECTION V.—MAN AND PROGRESS

(a) *NATURAL*

(b) *ARTIFICIAL*

LIST OF COLOUR PLATES

An Insect Hercules

Concerning the Ant—a Hercules of the Insect World—Some Instances of his Amazing Strength

By HAROLD BASTIN

Author of "Insects: Their Life Histories and Habits," &c.

IT has sometimes been said that if a flea were as large as a man, it would be quite capable of clearing at one bound the gilded cross that tops the dome of St. Paul's Cathedral; but this really puts the cart before the horse, with the usual unsatisfactory result. If we were to make a model of St. Paul's, having the same relation in size to the flea that the real building has to a man, then doubtless the flea could leap over the model. But this is quite a different thing from saying that a giant flea, equalling a man in bulk, could leap over the actual St. Paul's as it now stands at the top of Ludgate Hill. In all likelihood our immensely magnified flea, when it came to jumping, would be unable to break the record established by human athletes, which is, I believe, a little over 6 feet. The reason for this (as explained by physiologists) is that when the size of an animal is increased according to any uniform scale, its muscular force necessarily decreases very rapidly. To put the case briefly we may say that whereas the weight of an animal is augmented according to its increase in length, breadth, and depth jointly—i.e. as the cube of any linear dimension—the contractile, or pulling, force of any muscle depends solely upon its sectional area, and is accordingly increased as the square of any lineal dimension. Thus, if the muscles of the flea possessed the same physical properties as our own, a uniform and progressive increase in the creature's size would tend steadily to detract from its agility, until at length, when its bulk equalled that of a full-grown man, its feats of strength would fail to excite our wonder.

Clearly, therefore, we are not justified in laying too much stress upon a prima

Photo Dr Alfred Giaduzzi

An Ant at Its Morning Toilet

One of a series of remarkable studies made while examining ants under the microscope

Cooshie Ants Carrying Leaves to the Formicarium, or Nest

(Drawn by A Hugh Fisher from material supplied by Dr Dixey of Wadham College, Oxford)

The feats regularly performed by ants in tropical countries need seeing to be believed Not only will they strip trees of their leaves and carry them away, as shown here, they will even raid houses and remove every particle of maize, sugar, etc, within

An Insect Hercules

facie comparison of insects and mankind when questions of strength and endurance are to the fore. Nevertheless, it is undoubtedly a fact that insects, judged on their own merits, possess great muscular force, and are able to perform labours which may be described, without exaggeration, as herculean.

One has only to watch a living insect engaged in the ordinary round of its daily duties and pleasures to realise that it possesses a fund of muscular force greatly in excess of its ordinary needs. Insects seem never to "save themselves." The American entomologist, Dr. H. C. McCook, has recorded some wonderful facts anent the scrupulousness of ants in matters of personal cleanliness, and has shown incidentally that these insects perform amazing feats of acrobatic skill without the least effort, and quite as matters of course. For example, an ant will hang nonchalantly from a grass stem by *the claws of one leg*, the while it combs its antennæ, cleans its five remaining feet, or bends its head upwards to lick its abdomen and furbish the joints of its armour. Indeed, thanks partly to the wonderful flexibility of its "waist," and still more to the tenacity of its muscles, an ant is able to assume and maintain almost any position that the need or fancy of the moment may prompt. Many stingless ants, when fighting, first bite their adversary with their jaws, and then, bringing the tip of the abdomen beneath the body, squirt formic acid into the wound.

The most impressive proofs of the insect's muscular force and power of endurance are, of course, the result of co-operative labour. In England we may search out the nest of the wood ant. The mound of pine needles and small twigs is, perhaps, 3 feet high and several yards in circumference. It surmounts a labyrinth of galleries and chambers which extend far into the ground below. Truly an astonishing achievement when we consider the diminutiveness of the individual ant! But the whole population of the nest is animated by tireless energy, and bound together by a socialism which, being instinctive, is absolutely relentless in its demands. Some idea of how the work is accomplished may be gained by watching the ants as they

Photo Harrod Baxter

Wood Ant in Its Attitude of Menace

The abdomen is depressed and the tip directed towards the foe, at which formic acid will be squirted

hurry to and fro along the roads which connect the nest with the various centres whence food and building materials are brought. There are no task-masters, and it is plainly evident that the insects are not bent upon the gratification of their own appetites. Yet each one puts forth its utmost strength, while several may often be seen toiling in company when an unusually heavy twig, or a fat fly or caterpillar, must be dragged across a rough piece of ground.

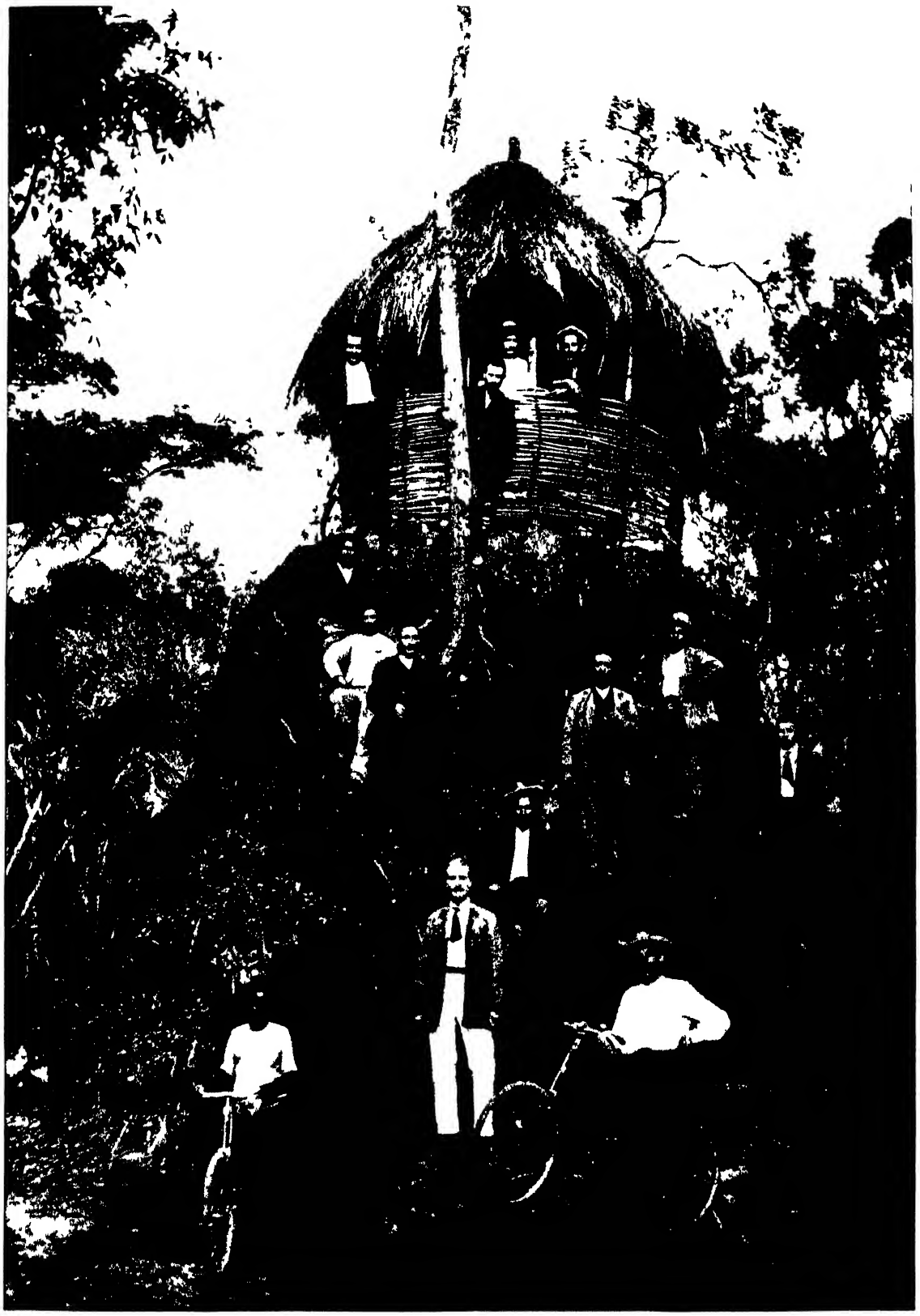
An Insect Hercules

In the tropics, where insects attain the zenith of their power, the results of the ant's strenuous labour are evident on all sides. There is an American saying to the effect that the ant rules Brazil; nor is this assertion groundless, seeing that the ant must be reckoned with in almost every phase of human activity. The Sauba, or Sauva, ants of South America are extraordinarily proficient in the art of subterranean mining, and are said, on the authority of the Rev. Hamlet Clark, to have tunnelled under the bed of the Parahyba river at a spot where it is as broad as the Thames at London Bridge.

Of the same insects the naturalist Bates writes that "at the Magoary rice mills, near Para, these ants once pierced the embankment of a large reservoir, the great body of water which it contained escaping before the damage could be repaired. In the Botanic Gardens, at Para, an enterprising French gardener tried all he could think of to extirpate the Sauba. With this object he made fires over some of the main entrances to their colonies, and blew the fumes of sulphur down the galleries by means of bellows. I saw the smoke issue from a great number of outlets, one of which was 70 yards distant from the place where the bellows were used. This shows how extensively the underground galleries are ramified."

These ants throw up mounds of earth above their nests which may be as much as 40 yards in circumference. They are also adepts at leaf-cutting, and will denude a large tree of its foliage, and carry the pieces away, in an incredibly short space of time. They frequently attack plantations of such trees as the coffee and orange, and are a serious menace to agriculture in the districts which they frequent. As an instance of their great physical strength, Bates relates that an army of Sauba ants once pillaged his store of farinha or mandioca meal, each individual carrying away a grain which was, in some cases, larger and many times heavier than its own body. This statement is confirmed by the Editor of this work, who tells me that he once had 25 lb. of maize removed from his

Co-operation in the Ant World



A Look-out Station Built by Ants

Such mighty ant-heaps are a regular feature of the landscape in many hot countries This photo shows one at Elizabethville, South Africa, which railway surveyors have converted into a look-out station

An Insect Hercules

Photo Harold Bastin

A Monstrous Termite Queen

Her egg-containing abdomen is 2,000 times the size of the rest of her body

house in Paraguay during the course of one night by a diligent band of ants.

The termites – the so-called "white ants" of tropical countries—are not to be confused with the true ants whose doings have been chronicled above. Termites are less highly specialised than ants proper, and do not pass through a quiescent, or pupal, stage in the course of their development from youth to maturity. Nevertheless, they resemble ants closely in their communal habits and manner of life, while their architectural triumphs are even more wonderful. The warlike termite of Africa builds massive conical hills, which sometimes attain a height of 10 feet, while the slender towers of a certain Australian species are occasionally as much as 23 feet high. The material employed is earth, very finely triturated in the digestive canal of the insect, and mixed with a cement-like secretion from the mouth. When set, this concrete becomes almost as hard as rock; so that the large nests can only be opened by means of gunpowder or dynamite. Perhaps the most amazing fact about termites is that the whole of the "labour" necessary for their vast enterprises is produced by one individual—the queen-mother of the community. She is housed in a special chamber in the centre of the nest, and certainly ranks among the greatest wonders of the insect world, her vast egg-containing abdomen being, in some instances at least, 2,000 times as great as the rest of her body. She is, in fact, a mere egg-producing machine, capable in favourable circumstances of adding to the population of the nest at the rate of 3,600 per hour.

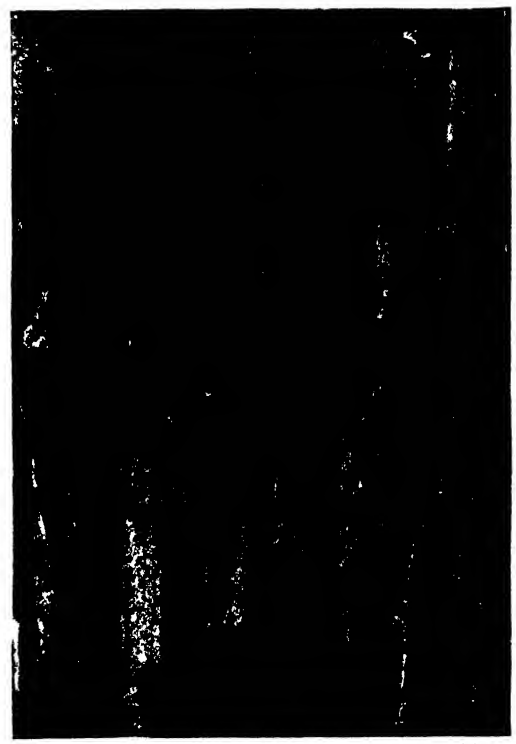


Photo Harold Bastin

Portion of a Tree Trunk

From Brazil, hollowed out by termites

Photo William Kathre

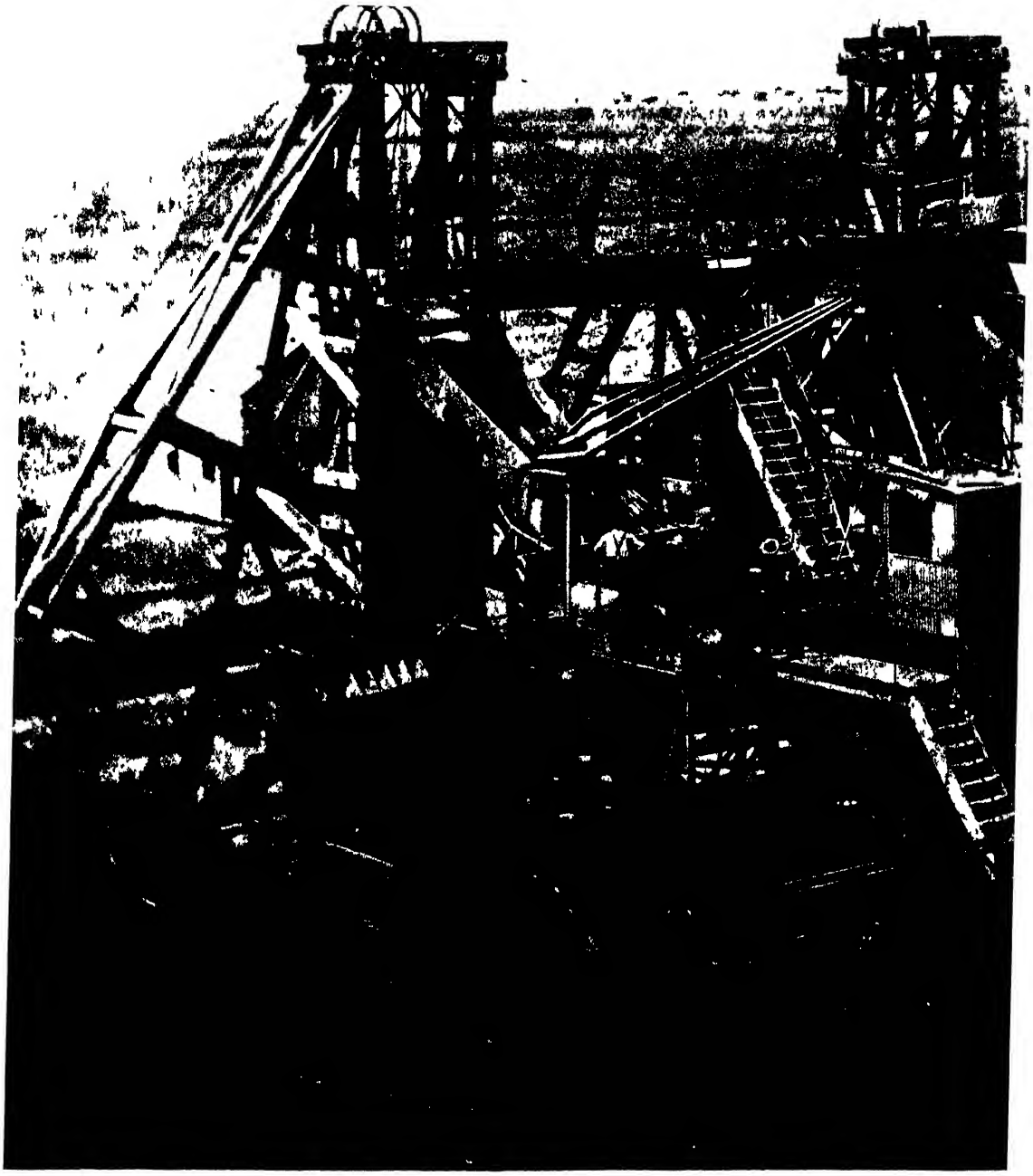
Searching Gravel for Diamonds on the Vaal River

The Magic of the Diamond

Mining in Search of the Gem for which the World Goes Mad

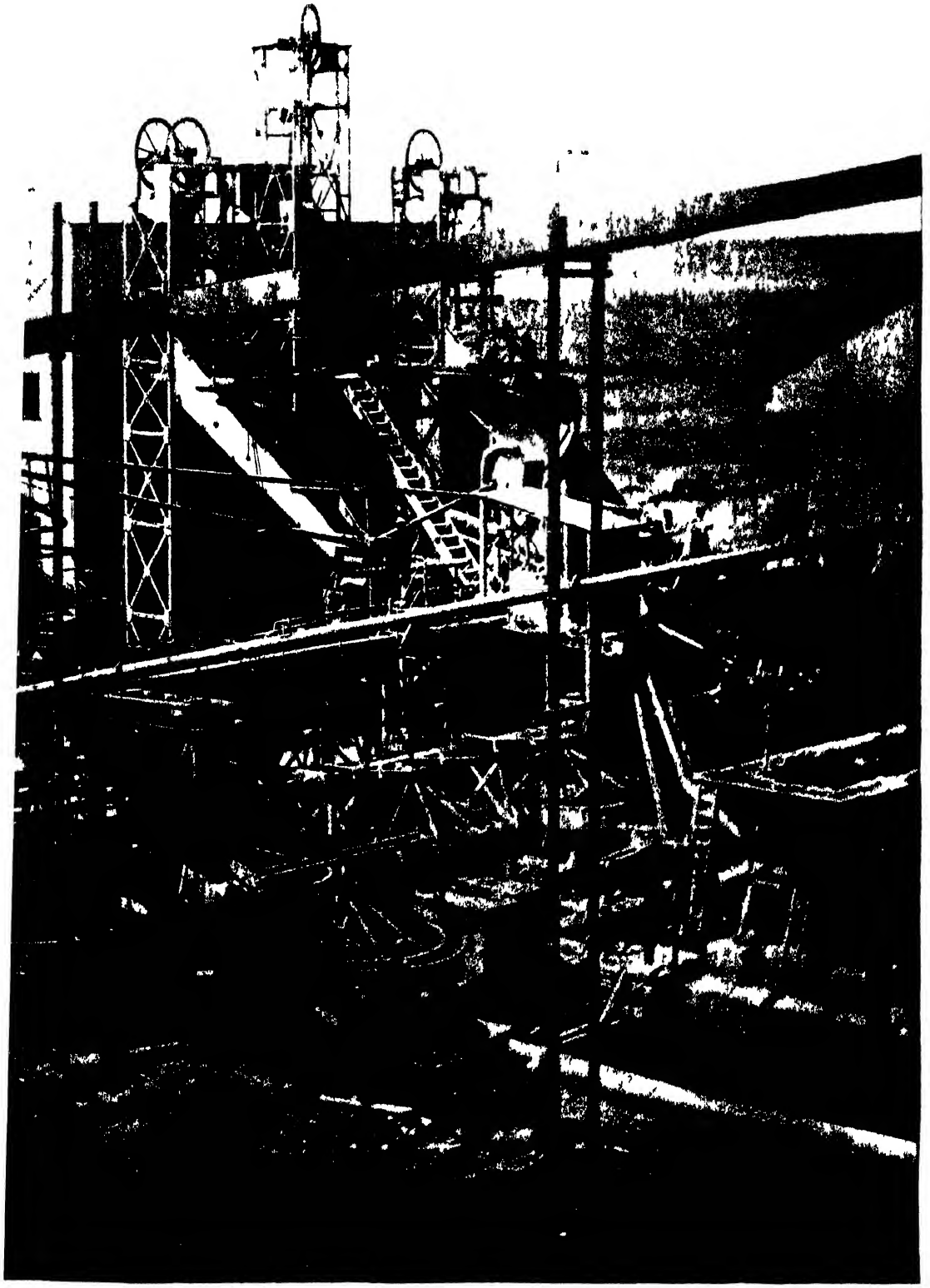
By N. F. WATSON

SWEATING savages, groping in distressful toil deep in the bowels of the steaming earth, are the genii who conjure the diamonds from their matrix of mystery into the light of day. The diamond begins its career in the hands of a jabbering Hottentot, and ends in the crown of a king. Thereafter it may involve intrigue and robbery, murder, war; for not even the divinity that doth hedge a king is invariably proof against the greed and daring of those that covet his diamonds. The story of every famous ancient diamond in the world has been written in blood and tears, from the incomparable Koh-i-noor, for which Indian empires were ravaged and overthrown, to the Pitt diamond which formed part of the booty of the Paris mob which carried out the September massacre in 1792, to be pawned, six years later, to furnish the cavalry for Napoleon's army of Italy, and afterwards to embellish the pommel of his coronation sword. If diamonds had been the forbidden fruit of Eden, Eve would still have fallen. Perhaps they were



THE GIGANTIC WASHING PLANT ON THI

After the toilers in the depths of the mine, 1,000 feet or more below the surface, have sent their car-loads of clay tc has rendered the clay less tenacious and more workable, it is conveyed to the washing plant. By whirling the mass heavier, sink to the bottom and are easily collected, ready to



H to William Hue se

DE BEERS DIAMOND MINES, KIMBERLEY

ıe pıt-head, thıs "stuff" ıs allowed to lıe for months on well-guarded drying grounds When exposure to the aır
ıth water the clay ıs drıven off wıth the waste lıquıd, whıle stones remaın behınd The dıamonds, beıng the
ˢ sorted over by nımble experts seated at well-lighted tables

beneath our first mother's feet. They are relics of an era more ancient than that of man, the product of our own terrestrial inferno; the creation of that most terrific of crucibles, the fiery heart of the world, where iron melts like sun-warmed ice, and carbon, by becoming liquefied, achieves that which science long held to be impossible.

Far beyond the range of man's observations lies the cradle of the diamond. The

Cradle of the Diamond

poet may sing as he will of "young diamonds bright in their infant dew," but the young diamond of reality comes to birth in a temperature as far removed from that of dew as is that of the electric furnace from the North Pole. No one has seen a natural diamond made, but two centuries of intermittent research have enabled science fairly thoroughly to probe the mystery, and to imitate, upon a microscopic scale in the laboratory of the chemist, the scheme by which the earth, in titanic travail, brings a diamond into being.

Long before Sir Humphry Davy and Michael Faraday, focusing the sun's rays by means of magnifying glasses upon a diamond, reduced the gem to vapour, we knew that diamonds would burn in high temperatures; we could convert them from their solid form into gas. The diamond is pure carbon. So, by a different molecular grouping, is the graphite of the lead pencil. So, too, for the most part, is coal. A diamond, exposed to heat in the presence of oxygen, vanishes into thin air in the form of carbonic-acid gas. The colossal Cullinan diamond, which weighed, when found, over 1⅛ lb., would, if submitted to heat, be reduced to a puff of gas such as the manufacturer of mineral waters employs to aerate a bottle of lemonade. But, under pressure, and with oxygen excluded, carbon does not vaporise; it becomes liquid. Deep in the incandescent strata of the earth molten iron reduces carbon to a fluid condition. The outer surface of the iron, as it cools, assumes greater bulk, and imprisons the molten core in a vice-like grip. Under that enormous pressure the carbon crystallises, and the result is—diamonds, the hardest minerals on earth or in the skies.

For the sky, like the earth, has its diamonds. They come to ground enclosed in meteorites, having undergone in those huge metallic bodies practically the same process which their terrestrial representatives have borne. The enormous fallen "star," known as the Cañon Diablo meteorite, in Arizona, which bored for itself a crater three-quarters of a mile in diameter and 600 feet in depth, and littered the plain for miles with fragments varying from ounces to hundredweights, is a treasury of true diamonds. The existence of diamonds here and in other meteorites has encouraged observers to declare that all our diamonds have come to us from the skies.

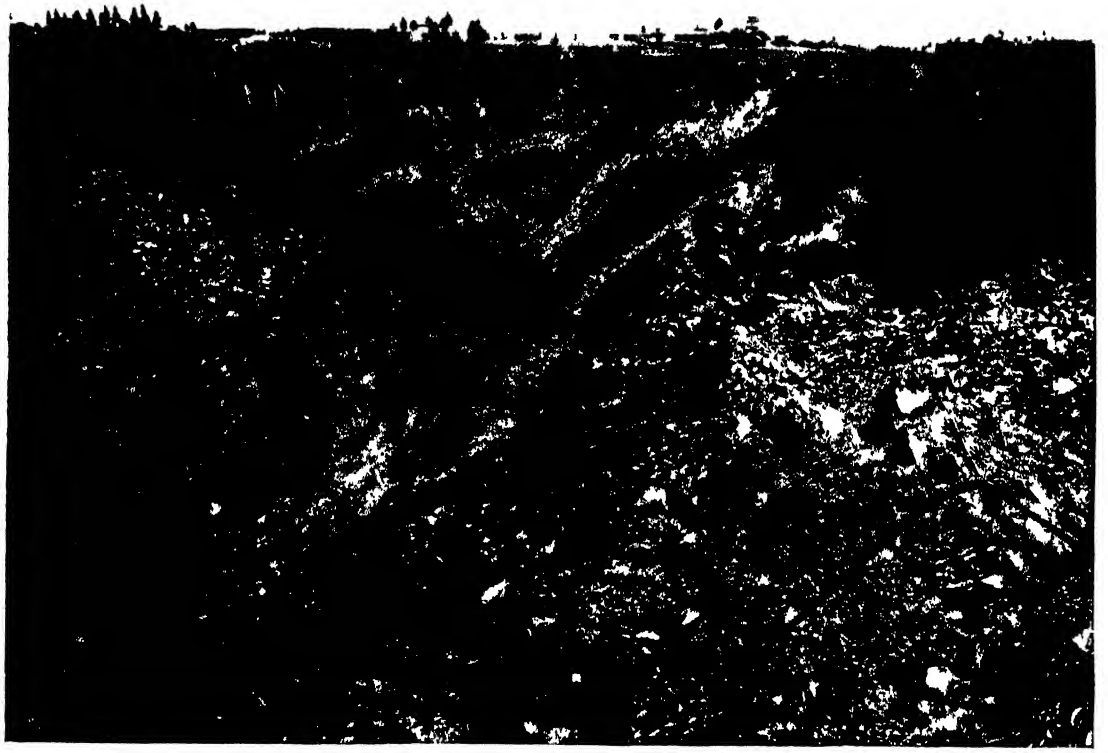
We find the gems, when mining, in what are known as volcanic pipes, running hundreds, even thousands of feet, sheer down into the earth, embedded in

Volcanic Pipes

the famous blue earth and in the hard unyielding bort. The conditions of the find suggest two theories. The first, and more favoured, is that the diamonds were created in the depths of earth by the method described, and thrust, by explosive volcanic action, upwards from their beds through funnels blown in the overlying strata by the forces exerted below. The pipes thus blown have dome-shaped crests, which by the eroding finger of time are worn down and their contents scattered, as gold, found in rivers or in the sands of old watercourses, has been scattered by time and tide from its original resting place. The scattered diamonds are the alluvial treasures which the fortunate wayfarer finds, and their discovery leads the expert to their source—the mines themselves. The second theory is that the pipes in which the diamonds are revealed are the old

channels by which diamond-freighted meteorites plunged into the earth after their lightning journey from the heavens. From what planet the meteorites came, or whether they solidified in space from gases such as first composed our own planet, none can say, but reputable astronomers and physicists hold that the meteorites that come to us do but return from age-long journeys, begun when they were shot out from the earth's interior by forces so unthinkable as to thrust them beyond the pull of gravitation.

Be that as it may, diamonds, terrestrial and celestial, await the searcher on the surface and deep in the earth. The Gaekwar of Baroda has, in the "Star of the South," a diamond of perfect water, worth, by mere weight, £100,000. It was turned up in the River Bogagem, Brazil, by a negress, fifty years ago. The diamond fields of South Africa, which have yielded, during the last few years, scores of millions of pounds, have been revealed to commerce solely as the result of accident. Half a century ago no one dreamed that a diamond existed in the whole continent. It was a happy-go-lucky Irishman who made the discovery. John O'Reilly, who was out in the Orange Free State for ostrich feathers, found the children of a Boer farmer named Niekerk playing knuckle bones with a number of stones which included one of a peculiar lustre. He drew the farmer's attention to it, and was told that it was only a "fierklip," one of the stones used for striking fire from steel. Niekerk made him a present of



The Original Workings at the De Beers Diamond Mines

A WONDERFUL PHOTOGRAPH OF A GREAT

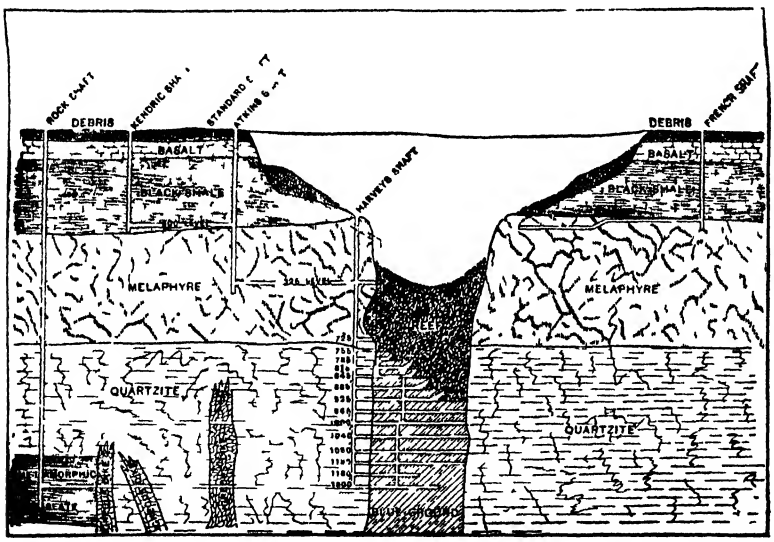
On the discovery of a new diamond field at Killarney, by an enterprising prospector, a great rush of thousands of El Dorado, the Civil Commissioner and Chief Inspector of Claims had certain formalities to attend to. On the "God save the King," as the Commissioner finished reading a proclamation, were the signal for the race to begin.

wide—ir

IAMOND RUSH AT KILLARNEY, SOUTH AFRICA

n (many with their families) to the spot took place. Before any could "peg out claims" on the new land of pointed day the eager claim-seekers were lined up (each carrying his pegs) as if for a foot-race. The words ithin a very short time 1,200 licensed diggers had each pegged out the plot—twenty yards long by ten yards ped to find a fortune

the stone, declining to sell it. O'Reilly carried it with him from place to place; scratched his name with it upon the window panes of various inns; was scoffed at for suggesting that it was a precious stone; threw it away, regained it, and took it finally to a lapidary at Capetown, who declared it to be a diamond, and effected its sale for £500 to the Governor of the Cape. O'Reilly returned to his farmer friend and divided his profits with him. Then Niekerk remembered that a certain little Bushman had been wont to carry as a charm a similar but larger stone, and set out to seek him.



By courtesy of The Macmillan Co., New York

From "The Diamond Mines of South Africa"

Section of Kimberley mine looking east (scale—670 feet to the inch)

The farmer followed the track of the savage through swamp and forest, but failing to find him, left presents of tobacco with his friends, bidding him hasten to the farm. In due time the little man appeared, and from a dirty bag, slung about his neck, produced his charm. The talisman of the naked savage is now famous as a diamond of unsurpassed quality, "The Star of South Africa," and was sold to the late Earl of Dudley for £30,000.

That was the beginning of the diamond industry of South Africa. Adventurers flocked to the Vaal River district, where diamonds were found in the mud with which the cottages were plastered, in the cement which held the stones together, and in the soil which Boers had for a generation been ploughing for a bare living. When the surface deposits were exhausted, shafts were sunk, and the pipes were discovered, and from haphazard individual ventures a mighty industry, involving capital beyond the dreams of company promoters, has grown up. The mines are worked day and night, seven days a week. Savages with pick and chisel and hammer win from the bottom of the shafts and out of the ramifying tunnels the stuff in which the diamonds are contained, and for five shillings a day handle that which may contain gems worth a king's ransom. The little pastoral district of a few years ago has become the world-famous Kimberley of to-day, which has made the fortunes of men such as Cecil Rhodes, the Barnatos, Sir J. B. Robinson, and other giants of finance.

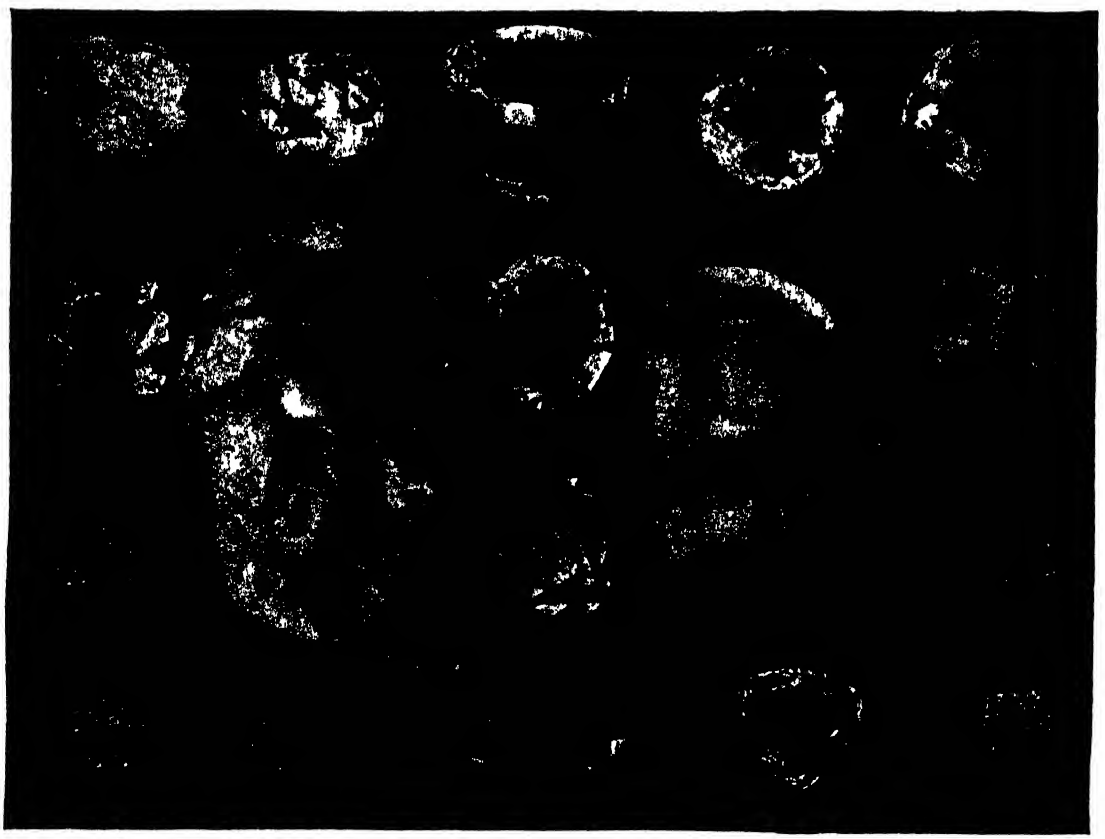
Of course there are other diamond fields—in India, in Australia, and on the American continent—and there seems no reason why many more should not be revealed, but South Africa is the diamond mine of the world. The romance of discovery is not yet over. Only last year rich alluvial deposits of diamonds were discovered in the neighbourhood of Bloemhof and Mooifontein, midway between Johannesburg and Kimberley. Diamonds had been turned up by the plough on Bloemhof farms, and systematic search presently revealed the existence of abundance of gems lying in old river gravel, six feet under the turf of the veldt

In a Kimberley Diamond Mine

The car-load of clay shown in the picture may contain gems worth a king s ransom

A couple of young farmers from Mooifontein, joining the rush to Bloemhof, were surprised to find the gravel there exactly like that on their own farm. They returned home and made a few trial washings, and very soon diamonds at the rate of £30,000 a month were being brought to light from the soil on which they had been content to grow maize and cabbages.

Diamonds are more plentiful than ever, but their cost to the purchaser steadily rises. As the demand for them increases, so the output is regulated, and prices maintained. There never can be too many, for if the seashore were pebbled with diamonds, the latter would have a value above that of all other precious stones. The hardest of minerals, the diamond is not only the adornment of beauty and rank but the invaluable ally of civilisation, in that it rips out the heart of mountains through which tunnels are to pass, bores the wells which are to water a parching land, and pierces the rock which imprisons the oil from which cars and cruisers derive their motive power.



Some of the World's Biggest Diamonds

1. Koh-i-noor (104¾ carats)
2. Lotetie d'Angleterre
3. Great Mogul of Russia (279$\frac{9}{16}$ cts.)
4. Orloff (194¾ cts. in rose form)
5. Koh-i-noor after first cutting
6. Regent, from the South African mines; bought for £400, valued at £500,000
7. Duc de Tuscane
8. Etoile du Sud, sold for £100,000. Found by negress in the River Bogagem
9. Etoile Palacre (140 carats)
10. Tiffany Yellow Diamond (125 carats)
11. Blue Diamond d'Angleterre
12. Great Sancy (53½ carats)
13. Empress Eugenie (55 carats)
14. Solesik of Russia
15. Nassak (78⅛ carats)
16. Pacha d'Egypt (40 carats)
17. Cullinan, before cutting (3,024¾ carats)
18. Jagersfontein (970½ carats)

A Gleam of Sunlight Shows the Vessel Labouring Heavily

The Typhoon

A Giant Fabled by the Ancients and Feared as Much to-day as in their Time

By REGINALD C. FRY

WHEN Nature chooses to assert her might man's most trusted safeguards are useless. Sometimes, as has been recorded earlier in this work, her manifestations take the form of volcanic eruptions, sometimes of earthquakes. At others, Nature, tired of the many chains with which civilised man has fettered her for his own advantage, runs amok and destroys him and the results of his toil.

Back in the ages that have given us our philosophy the Greeks wrote of Typhon—a many-headed monster of malignant ferocity. Imprisoned by Zeus in the heart of the earth, he caused volcanic eruptions and earthquakes, and was the father of destructive winds. It is from him that the most potent and dreaded of storms derives its name.

A typhoon, briefly stated, is a circular storm of terrible immensity that sweeps the eastern seas from Japan to the Philippine Islands. During August, September, and October typhoons circle over many

The Typhoon

degrees of the eastern hemisphere. As this is the season when the rice crops flower, the damage, and subsequent loss, is vast. Typhon's onslaughts cost many thousands of lives yearly, in addition to wrecking ships, destroying roads, buildings, bridges, and allowing the sea to flood the land that many years have been spent in reclaiming. The annual cost of the typhoon's fury amounts to millions of pounds.

It is upon the sea that the typhoon is most dreaded. When the signs of an approaching storm are displayed in the sky, or upon the surface of the water, the mariners of the Orient hasten to steer shorewards, or if they are too far from land, to "trim up" their frail ships to meet the terror that is upon them.

Deep-sea skippers, as they read the rapidly-falling glass with anxious eyes, knit their brows as the mercury drops in the barometer. But they need no barometer to interpret the ominous calm that has enwrapped sky and sea. They know their danger from grim experience, and watch the ominous spurts of foam flying upward from a short-running sea with worried faces.

Let us pass in imagination through a typical typhoon, occurring, say, at noon, in the Indian Ocean.

A clammy heat precedes the dreaded manifestation, and beneath the vessel's keel the sea rises and falls in a rapidly growing swell. She lurches heavily as smooth hollows open out to receive her bulk. From an obscured sun eerie rays slant across the waters and shine sickly on the ship's hull. Right ahead a dense bank of clouds blots out the gorgeousness of the eastern sky, from which, through a rift, dark-framed by the mass of storm-cloud, flashes for a moment a glare of red light from beyond.

Dark and ominous, the clouds crouch near the horizon, seeming like an impenetrable barrier to the look-out man's gaze, as the ship steadily heads for it. With the falling glass and the rising sea, the light fails of a sudden, and gloom, like the fall of night, descends over all. The wind gathers force and rushes upon the ship with the storm's approach.

A little later a welcome gleam of sunlight through the gloom shows the vessel labouring heavily. Her antics are absurd. Like a cork she is lifted bodily and flung here and there in a hissing sea. The voice of the gale by now has increased so that all sounds are deadened throughout the ship, and with a mighty charge the storm hurtles upon her. A dread feeling comes to all on board as the vessel heels over until her decks are almost upright, and her spar-ends touch the rushing seas that strain her. Barely heard above the noise of the gale, sharp splintering cracks tell of lifeboats wrenched bodily from their lashings as they are swept from the parent

The Calm Before the Storm

The sails hang idly in the breathless air

The Typhoon

Dark and Ominous the Clouds Crouch near the Horizon

With the falling glass the light fails of a sudden, and gloom, like the fall of night, descends over all

hip. From keelson to main deck every bolt and timber, rivet or steel plate complains against the bullying.

With a noise like the falling of some huge body, seas, to the extent of hundreds of tons a minute, are flung over the stout bulwarks to thud on the sodden decks, ere they rush helter-skelter out through the banging scuppers. Ahead, from starboard bow to port bow, a startlingly vivid lightning flash, that on any other occasion would be watched with admiration, tears the black pall of cloud from horizon to horizon. Like the sudden flash of a battleship's searchlight, it lights up a raging sea crested with curling foam, and about the vessel's deck black shadows of men dart hither and thither, bent on their business. The lines and rigging of the ship show like a spider's web for a brief second before darkness falls once more upon the maddened sea.

Under the force of the storm the ship is buffeted about like a toy, now poised on high on the crest of some towering wave, now sucked down into the deep hollows of the ocean as if going to her doom. Sails,

Signs of an Approaching Storm

Deep-sea skippers watch the ominous spurts of foam flying upwards from a short-running sea with anxious faces

The Typhoon

awnings, boats—everything is swept from her decks that the tempest once gets well hold of. Clutch as they will, some of the crew perish, snatched from security by the relentless hand of the typhoon and flung into the sea.

When the vortex of the storm is upon the vessel Dante's "Inferno" could not hold a more terrifying spectacle. The ship is actually held stationary by the conflicting forces of the wind, which strive to drive her simultaneously in different directions. None but the stoutest of vessels could for an hour sustain that prodigious wrenching, and it is few ships that have lived through the full force of the eastern giant. The vortex of the storm may be between thirty and forty miles wide, and travelling at seventy-five miles an hour (faster than an express train). Coupled with this aerial might the bombardment of the waves joins in the work of destruction; by their combined malice many a good ship has been rent asunder and smashed to match-wood. The wonderful photographs by Mr. William Hope Hodgson of the heart of the storm, are probably the only ones of their kind that have ever been taken.

A Terrifying Spectacle

With a noise like the falling of some huge body, seas, to the extent of hundreds of tons a minute, are flung over the stout bulwarks to thud on the sodden decks, ere they rush helter-skelter out through the banging scuppers

As to the causes which give rise to the typhoon or other cyclonic storms, some diversity of opinion exists. The following explanation seems reasonable: "A stratum of hot air, made hot by contact with the hot earth and by the power of the sun, is

The Typhoon

Dangerous Following Seas

The ship is actually held stationary by the conflicting forces of wind and wave which battle together

overland by a stratum of cold air From the greater weight of the cold air the natural tendency of the hot air to rise is restrained, some cause local or general forces an intermixture of the two strata at a particular point and establishes the nucleus of the storm. The intermingling of the unwilling elements gives rise to considerable atmospheric disturbance, and the particles of air, rubbing against one another, get whirled round in a direction suggested by the motion of the earth at the place of disturbance. The example set is followed by adjacent blocks of air, and great bodies of wind, co-extensive with the masses of hot and cold air, are set in motion, taking their revolving rate and direction from the heat or nucleus of the storm. The storm acquires strength in rolling, until the whole attains a circular velocity in severe hurricanes of 100 miles an hour. But the storm travels, that is to say it has two motions, its own circular motion, and also the direct motion of the wind prevailing at the time '

The Storm Abates

The sea is dying down

A Cyclonic Sea at the Heart of the Storm

Few ships that have passed through its worst phase have lived to tell of the terrors of the dreaded typhoon

The Strongest Ship in the World

How the Ice-breaking Vessel "Ermack" Keeps Open the Baltic Ports in Winter

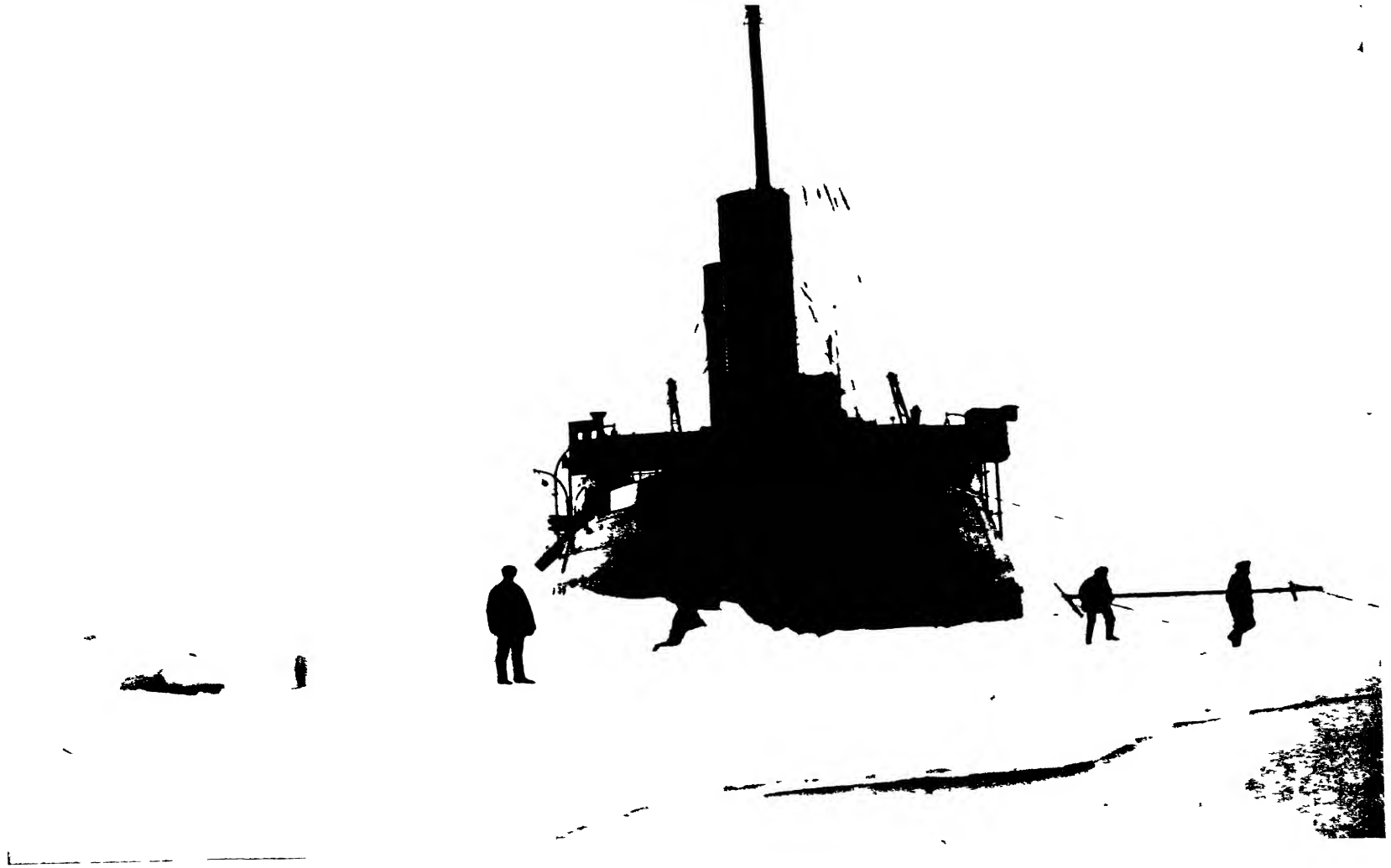
By H. J. SHEPSTONE

UNIQUE among boats is the Russian ice-breaker *Ermack*. On account of her peculiar formation and design she can claim to be the strongest vessel afloat. Indeed, her designers declare that if she were lying on her beam ends alongside a quay 300 feet long, at each end of which there was a giant crane with a lifting capacity of 4,000 tons, and these two got hold of her and lifted her clean out of the water, she would hang between them as rigid as a bar of steel. If the same test were applied to a Dreadnought, or any other battleship in the British Navy, it would crumple up by its own weight.

This unique example of the shipbuilders' art is nothing less than a hull of steel 305 feet long, 71 feet broad, 42 feet 6 inches deep, having a displacement of 8,000 tons, and driven by the concentrated energy of 12,000 horse-power. She is a double ship from end to end, and her two skins are so connected and fortified by bulkheads and longitudinal bulkheads, or, as we should say in landsman's language, partitions of steel framed in girders of enormous strength, that they are practically uncrushable, while the ship herself is practically unsinkable. She is divided into forty-eight watertight compartments.

Her mission on the sea is to keep the ports of the Baltic open during the winter months by cutting a passage-way for other ships through the thick ice. When she is caught, as she has been many scores of times, between a couple of closing masses of ice, she at once rises slowly and easily, and without so much as a shiver Then, if her weight of 8,000 tons is not sufficient to break the ice, her powerful pumps are set to work, and certain of her compartments are filled with water. In this way an additional weight of 2,000 tons is obtained, making a total of 10,000 tons. The ice has either to support this weight or give way. Hitherto it has always done the latter. Her keel and sides are as round as an apple; there is not an angle for the ice to grip. Last season she rescued 120 steamers that were unable to extricate themselves from the ice.

After the Typhoon has Spent its Force Calm Reigns Again



The Russian Ice-breaker "Ermack

This unique example of the shipbuilders' art consists of a hull of steel 305 feet long, 71 feet broad, 42½ feet deep, having a displacement of 8,000 tons and driven by the concentrated energy of 12,000 horse-power. Every winter, while engaged in keeping the Baltic ports open, she is called upon to smash up ice twenty feet and more in thickness

A Monster Devil-Fish

Monsters of the Depths

Concerning the Awful Shapes that Inhabit the Mysterious Depths of Ocean

By FRANK T. BULLEN

Author of "The Cruise of the 'Cachalot'"

BUTTRESSED by bars of brass, and cased in triple steel, must have been the breast that braved the terrors of the unknown ocean, said the Greek seer, but even he did not loose the flood of his eloquence upon the possibilities of an invasion of ocean's depths, arguing probably that such a journey by man was unthinkable. Even to-day, with all the achievements of science, that vast realm of dimness and teeming life is as absolutely sealed against man's visitation as are the stellar spaces. Some knowledge of the conditions of life down there has been obtained by means of cleverly-invented sounding lines and drag nets—considering the enormous depths thus searched, knowledge far greater than can be realised.

But such knowledge is severely limited with regard to the size of those deep-sea denizens. The specimens of deep-sea fish which have been brought to the surface and photographed have been appalling in their hideousness, terrible in their potentialities of destruction of one another, but they have necessarily been small and, moreover, there has always been a doubt as to the depth of their habitat, whether they may not have been trapped in the net when it was ascending or descending. So that we are as far as ever from absolute knowledge of the ocean bed, or whether it is a dwelling-place for appalling monsters of

the sea-serpent type. Indeed, if the small specimens of fearsome fish which have been brought to the surface are only immature representatives of immense predatory creatures that haunt those darkling depths, we need not exercise our imagination—the actual creatures are sufficiently terror-striking to justify any awe producible by even the sea-serpent of the Hindoo mythology.

Fortunately for mariners—although the speed of ocean steamships to-day precludes the idea of any attack being successfully made upon a ship by monsters of the depths—the conditions under which life is maintained at great depths vary so greatly from those at the surface that it is impossible to imagine any creature of the deep sea coming to the surface voluntarily, or arriving there alive. The pressure at those great depths is tremendous (several tons to the square inch), and the removal of this pressure in the sudden upward transition of a fish coming to the surface is always disastrous to the creature, often resulting in his being turned inside out before reaching the top.

Therefore, while it is impossible to say definitely that the ocean depths do not hold monsters terrible of aspect as the creations of a fever dream and vast as the popular idea of a sea-serpent, it is equally impossible to imagine such creatures coming to the surface alive. Strange forms have been upheaved in some stupendous sub-marine convulsions, but, *pace* Kipling's fine sea-serpent story, never alive. But thanks to the energy, perseverance, and skill of oceanologists, we are able to form an excellent idea of the appearance of many of these denizens of the depths of which the illustrations give a very comprehensive idea.

Still, in spite of all that we know to be true concerning the impossibility of the worst horrors appearing alive to the starting eyes of men, there will, there must always be, some lingering doubt as to the potentialities of unknown monsters of the

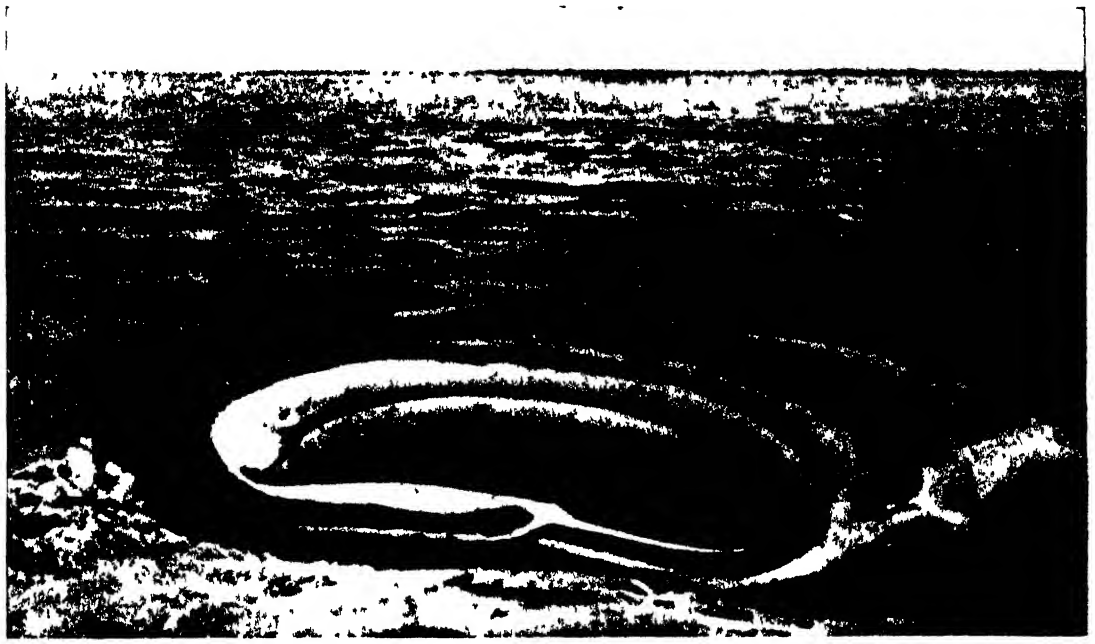


Photo Bavirt Dominick Fun

A Fishy Crater

This dreadful creature with the yawning mouth, a veritable monster of the sea, is a stranded devil-fish of the same type as that illustrated on the previous page

A Giant Octopus and a Giant Squid in their Native Element

(Reconstructed by A Hugh Fisher, from Models in the Natural History Museum)

While the habitat of some of the most hideous monsters of the ocean lies so deep below the surface that man cannot reach them, and it is impossible for them to rise without perishing we can gather an idea of their shape from small specimens that have been drawn to the surface With the squid and the octopus we are more familiar As related on page 38 there are men living who have escaped from

Photo F. Martin Duncan

A Wonderful Photograph of a Crab Seized and about to be Devoured by a Small Octopus *(Eledon)*

"The Octopus generally spends the hours of daylight comfortably concealed in a rock cranny," says Mr Martin Duncan, who has studied the monster, "or he may sit at the entrance to his grotto and fish for unwary crustaceans and other denizens of the deep that may pass within reach of his long arms

deep whenever it happens (an occurrence now very rare, and growing rarer every day) that a vessel remains motionless as far as progress is concerned, for any length of time in abysmal waters. It befell me once to be so detained, in an old coal laden ship bound from Liverpool to Bombay, when for lack of wind in the Southern Indian Ocean we did not in six weeks go twenty miles. The impressions made upon my young mind by that tense period are ineffaceable, but chief among them are the terrors that every night brought. For then the glassy, greasy-looking sea, so lifeless and void by day, became full of fire, life, and movement. It is true that all was indefinite, the vast shapes that moved beneath us seemed to possess no outlines, and their palely gleaming masses blended strangely with their surroundings, yet it was just that impalpability of outline, allied to stealthy gliding movement, that was a chief element in the terror.

Whenever we recognised a quick, certain movement, and knew it for the wake of an

A Monster 1,600 pound Sun Fish Caught by Women

Our picture shows a huge fish caught by the three women beside it. It is a sun fish, weighing 1 600 pounds, and is said to be the record catch of that sort. It was captured off Catalina Island, famous all over the world as a piscatorial paradise. This queer creature is almost tailless and propels itself by the powerful dorsal and anal fins the pectoral fins being small and comparatively weak. It has prominent eyes and a small mouth with an undivided dental plate, somewhat like that of the turtle. It has no value for food, as the flesh is tough and stringy, but oil is sometimes extracted from the huge carcass. It is stated that the name of the sun-fish is given to this creature from its habit of basking on the surface of the water in bright weather.

honest fish, we felt a pang of relief, even though its hugeness showed it to be made by a great shark. At any other time the close proximity of the great predatory fish would have filled us with disgust and hatred, but not now; our minds were otherwise occupied. Put briefly, those nights revealed to

us, as never before, the fact that the element upon which we floated was practically alive, not merely the abode of life, but, as we looked down into it from the upper darkness, life itself, life in solution. To none of us, I am very sure, had the wisdom of these latter days been taught which shows that the ocean is the source of life, but I feel certain that we all dimly apprehended it, and the inchoate idea curdled our blood as we looked into the glowing depths. With the first breath of a steady wind all our terrors took wing, and were soon forgotten with the easy facility of the sailor, or only remembered on special occasions.

Cuttle Fish on the Look Out for Prey

It comes to this, then, that as far as size and hideousness and savagery are concerned the monsters of the ultimate depths do not exist for us. In the realm of absolute ignorance, imagination is king, and we may people those dim unknown shades with what awful shapes we choose, secure in the knowledge that an immense and impassable barrier separates us from them.

The Romance of the Channel Tunnel

Concerning the Dream of a Century which has been Started and Discontinued Again and Again. Will It Soon be Realised?

By E. A. BRYANT

Author of "The New Self-Help"

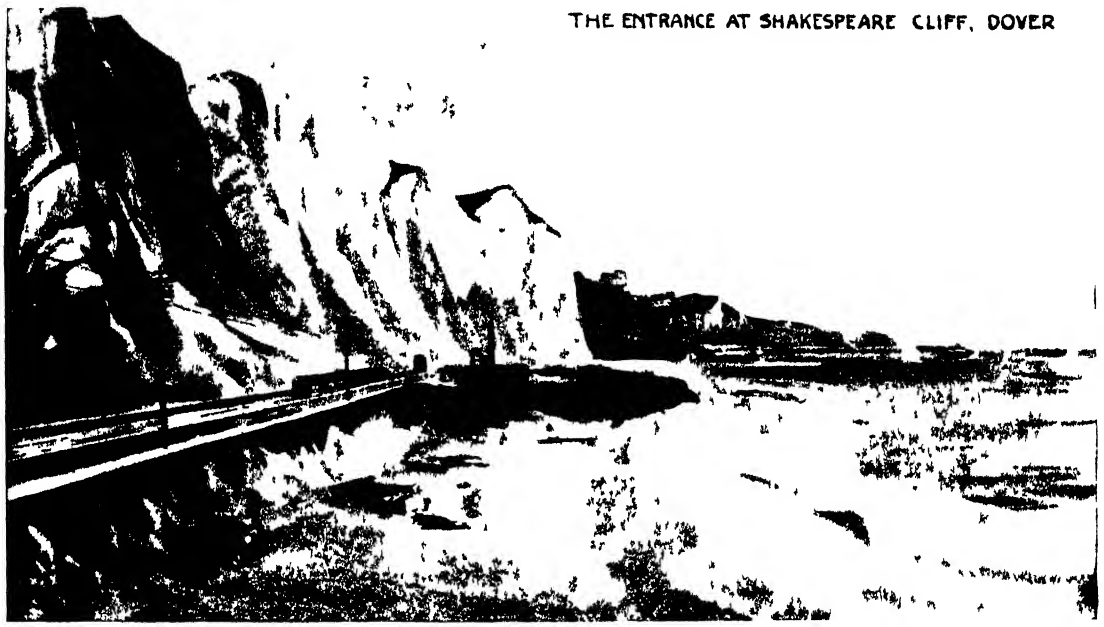
JULIUS CÆSAR came to Britain for gleaming pearls, and marched his legions over unsuspected black diamonds. Sir Edward Watkin, our Cæsar of the railways, sunk a tunnel and a fortune at the Romans' landing-place, and revealed an underworld Cæsar never knew. He revealed a coalfield underlying the garden of England, from which, perhaps, electrical power may some day be generated for driving trains through the tunnel by which he set out to restore the physical continuity of England and France. The Channel Tunnel that he essayed to build remains the beginning of a dream which started to come true; the coal that he accidentally exposed to the mining world is now being rived from its ancient bed to feed South Eastern locomotives. The tunnel is the vision; the coal the material outcome.

Perhaps the dream will go no farther. Military opinion is invincibly opposed to

it. Our soldiers and sailors tell us that the tunnel must not be made, and the man in the street, when he thinks about the matter at all, probably agrees that those who might be called upon to defend the tunnel, should it be made, are best qualified to advise him.

There may linger, of course, the uneasy reflection that every revolution, such as this Channel Tunnel would mark, has been

THE ENTRANCE AT SHAKESPEARE CLIFF, DOVER



Present Entrance to the Tunnel at Shakespeare Cliff, Dover

assailed by arguments as emphatic as any advanced against this submarine way to the Continent. Steam railways were declared an impossibility; the steamship a ludicrous misunderstanding of the nature and requirements of the steam engine. The electric telegraph moved the Government to the loftiest scorn, for they had, they remarked, the excellent hand-worked semaphore system all the way from Dover up to town. The use of anæsthetics drove the British public to a frenzy of indignant protest. The grass is not yet green on the grave of the man, Sir William Preece, who, himself a pioneer of wireless telegraphy, laughed cynically at the suggestion that wireless telegraphy could ever be commercially possible on an extended scale.

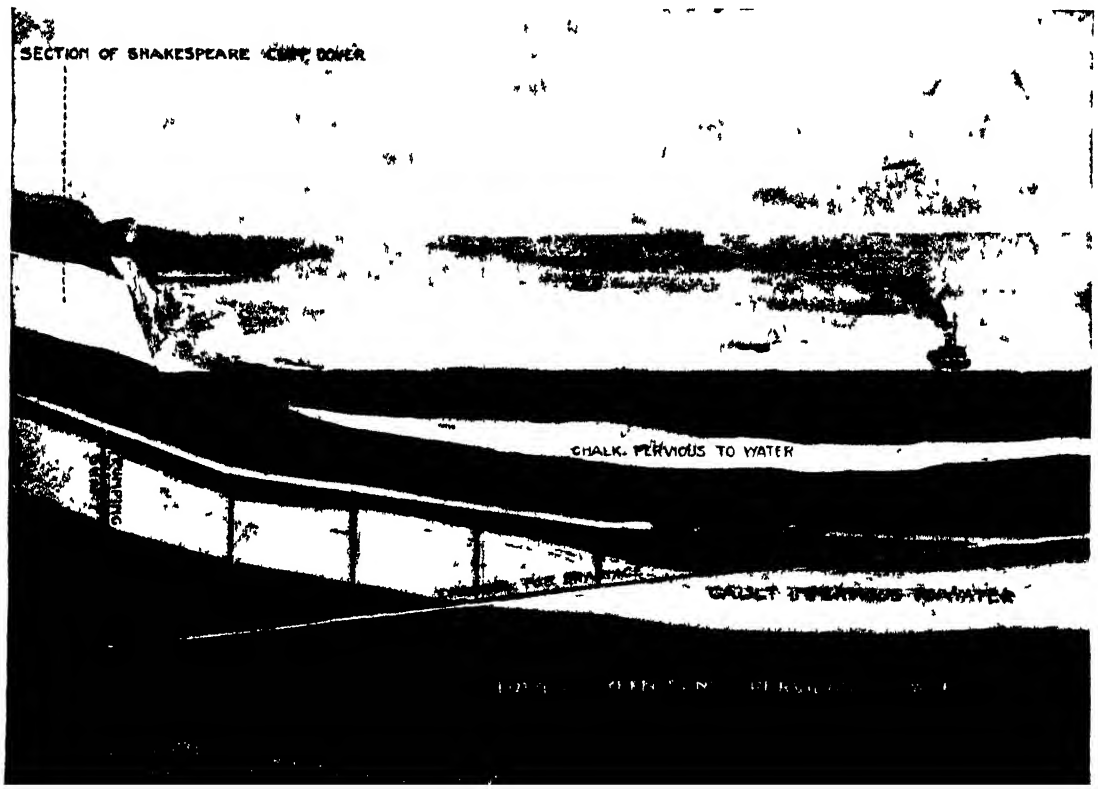
The nearest analogy to the case for and against the tunnel is presented by the declaration of Lord Palmerston as to the Suez Canal: "It shall not be made, it cannot be made, but if it were made, there would be war between France and England for the possession of Egypt." And yet the Suez Canal has been made. We draw from it yearly a princely revenue, a profit as big as that of the entire General Post Office, and France, instead of going to war with us for the possession of Egypt, is actively seeking to join hands with us under the sea by way of the proposed Channel Tunnel.

Of such are the reflections which inevitably arise when we agree that the military advisers of the country are right in declaring the tunnel must not be.

And yet the beginning of it is there already. The Channel Tunnel already runs —a seven-foot headway, from Shakespeare Cliff at Dover, a distance of exactly a mile and a quarter under the Channel. On the French side there is a corresponding tunnel

running a like distance under the sea. The fact is, the Channel Tunnel is one-tenth made Its building has been sanctioned, and interdicted, again and again. Every new idea in locomotion has brought fresh force to the plans for the tunnel. The tunnel scheme has had to compete with many rival schemes—with plans for the already over stretches of sea almost equally wide in the more northerly waters of Europe.

The tunnellers hope from the fact that train-ferries do not avert sea sickness, whereas submarine ways through the chalk do And when they are told that the tunnel would render our land no longer an island, they retort that the aeroplane



A Transverse Section of the Proposed

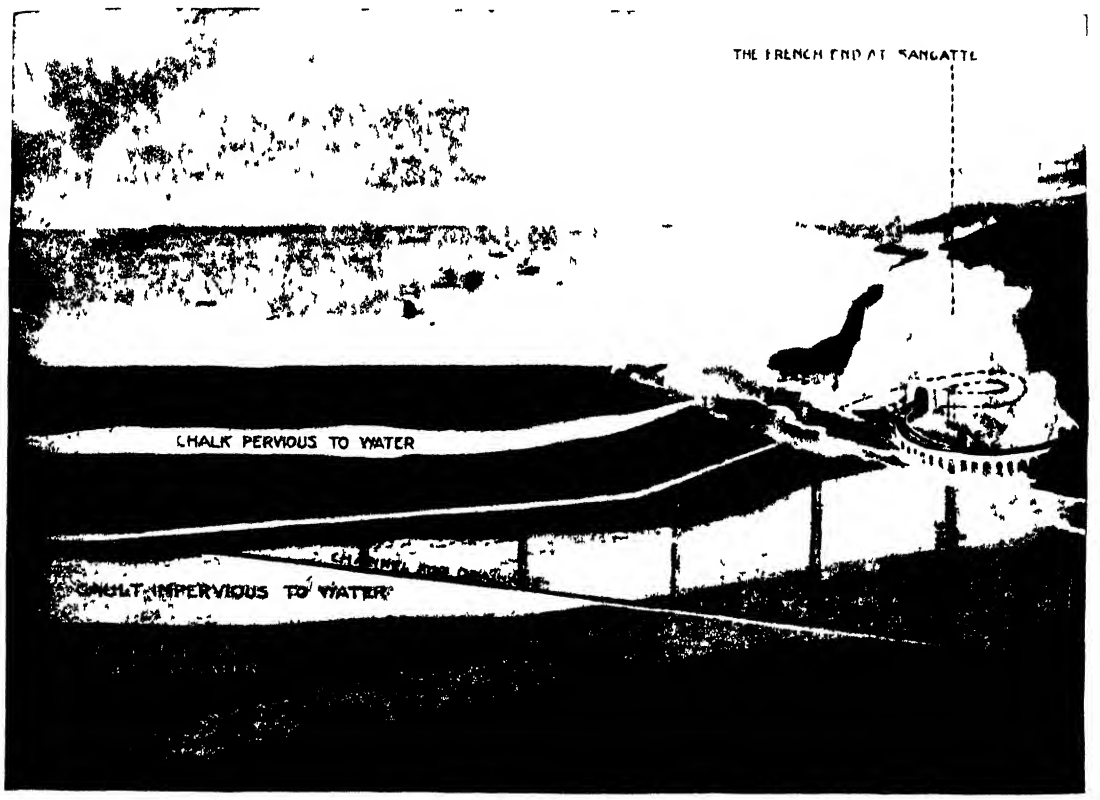
A tenth of the entire distance from shore to shore has already been pierced During a period when out a mile and a quarter to sea, while work on the French side was thrust forward with the

creation of stepping stones of artificial islands from which bridges for the conveyance of trains would leap; with tubular bridges such as that which spans the Menai Straits; with the latest and most formidable rival, the Channel-ferry idea, ferries which pack trains on to their decks, without passengers quitting their seats, without cargo breaking bulk. The train-ferry is the most likely to win common support, and conceivably we may ere long see it in operation across the Channel, as it is and the dirigible have already relieved us of all sense of insularity. And they add a quotation from Queen Victoria who, with the best military and engineering advice of her generation, informed M. Thomé de Gamond, the French engineer with a tunnel scheme, "If you succeed in doing that, I will bless you in my own name, and in that of all the women of England."

We all ought really to know whether we want the scheme or not, for eleven decades have passed since Mathieu, the French

engineer, mooted it to Napoleon. He proposed two tunnels, one from the English and one from the French coast. They were to meet midway at the submarine bank of the Varne, which is only 19 feet below the sea level. Here he was to raise an artificial island, and to found an international town. The Americans have done

It is strange that Napoleon had the first offer of this tunnel, for he had also the offer of the first steam battleship. Fulton would gladly have built him the latter. A single steam vessel of war might have saved Trafalgar, have paved the way for the actual coming of the Army of Invasion in whose honour a medal was a little pre-



Channel Tunnel, showing the Strata to be Pierced

objectors to the project were quiescent the tunnel was begun at Shakespeare Cliff, Dover, and run same success Then Parliament interfered and forbade the union Will it ever take place?

something of the same sort on their new Florida railway out to sea, only there the coral polypi had built the island ready for the city. This first of projected Channel tunnels was to contain a paved way, to be lighted by oil lamps, and have ventilating shafts emerging from the water. Horses were to supply tractive power, a scheme which would have entirely suited Sir Robert Peel—who considered the railway admirable for horse haulage, but wholly unsuited to locomotives!

maturely struck, and have enabled Napoleon to build a tunnel to keep open communications between France and a conquered Albion without let or hindrance from the stormy seas of the Channel.

The great man left the construction of the tunnel to posterity; and other geniuses, or madmen, elaborated plans without end for burrowing beneath the blue. They talked then, though in smaller terms, as we talk to-day, of their bridges, their ferry-boats for wheeled vehicles, of their

submerged tubes, before the first of our tube railways had come into being. But, beyond arousing curiosity and interest, they achieved nothing. Imagination was stirred, however, by the labours of Thomé de Gamond, whose scheme won the approval of Queen Victoria. A military mining engineer, he devoted practically his whole life and fortune to the problem, which he attacked with the ardour and persistence of a skilled enthusiast. If the scheme should ever come to anything we are bound to have recourse to this unselfish zealot's work, for our knowledge of the bed of the Channel is really founded in the main upon his unwearying investigations. He had a variety of suggestions, some of them a little fantastic in view of present-day engineering methods, to say nothing of the prodigiously deep fairway required for the modern steamer. One scheme was a resuscitation of the submerged tube of metal; a stranger one was a plan to build an arch resting upon the bed of the sea—a submarine arch of concrete, suggested long before the use of reinforced concrete for subaqueous work had been deemed possible by engineers in general.

Approved by Queen Victoria

Just as Mathieu had approached the great Napoleon on the subject, so Gamond took his schemes to the tyrant's nephew. He did not go with mere empty theories. He had worked out his plans at the risk of his life. For he had descended into the depths to see for himself of what the sea-bed was composed. One might almost venture to say that his diving feats must have constituted a record. The native pearl divers of Ceylon and Australia are supposed not to descend to greater depths than eighty feet or so, but Gamond crept 108 feet down, without a vestige of diving apparatus. He simply hitched himself to a rope, weighted himself with sacks of pebbles, and down he went. With his 160 pounds of ballast he flopped out of his little boat, with a few kindred enthusiasts to watch over him, and with his devoted daughter to supervise their operations. Innumerable descents he made to find out what the loom of time had fashioned beneath the waves. He took samples of the ooze and clay into which his native land is being resolved by the winds and frosts and rains, to be carried slowly out to sea.

He tested the chalk, the friendly, indispensable chalk, in which his trains must run. And he went to Louis Napoleon prepared to build the French half of the tunnel. Napoleon III. and his Empress had had a big share in forwarding the Suez Canal, whose projector, De Lesseps, was a cousin of the Empress. They listened with avidity to the suggestion, for the feeling between France and England was very friendly. Help was promised from the English side, and a renowned triumvirate, Isambard Brunel, Joseph Locke, and Robert Stephenson, were ready to contribute their quota to the work.

Quite an illustrious company of ocean moles was thus assured, and the long and short of it was that in 1870 the British Government agreed in principle to the work. That was a fatal year for the tunnel. One of the great stumbling blocks to-day in the way of the work is that, even should the friendship of France for England remain for ever unimpaired, there is no certain guarantee that a foreign Power might not invade France, as happened in 1870, in which case the French end of the Tunnel would then pass from the control of our friendly neighbours, and so involve all sorts of unpleasant international possibilities. But, in spite of the warning of 1870, the work was re-considered a few years later, and in 1876 the two Governments signed a protocol which one believes still holds good. Bills for a Channel Tunnel have from time to time been before Parliament, and, with the consent of both great parties in the State have been rejected as inexpedient for the national

A Fatal Year

welfare. But that protocol still yields a jumping-off point, and would only need ratification to enable the two countries to build out, each from its own shore, to meet midway through the Channel, as the engineers of the Alpine tunnels meet in the middle of a sky-piercing mountain.

Enormous Cost Already

Various companies have from time to time been formed to carry on this work of thrusting a tunnel under the Channel through which trains should pass. Hundreds of thousands of pounds have been spent on the works, and still larger sums on Bills before Parliament, on Commissions and what not. At one time we had no fewer than three companies simultaneously at work on the tunnel scheme on our own side of the water. Finally, the South Eastern Railway swallowed the other two, and opened negotiations with the Northern Railway of France, and the works were pushed out to sea, eastward from Dover, westward from Sangatte, four miles west of Calais. Ultimately the rights of the South Eastern company were acquired by a company, in which the railway had a considerable holding in shares, a company founded exclusively for the purpose of building the tunnel.

The tunnel was begun at Shakespeare Cliff, Dover, and was run out, as already mentioned, a mile and a quarter to sea, while work on the French side was thrust forward with the same success. Then Parliament interfered and forbade the banns, so to speak. The union has never taken place, though a further proposal was before the legislature in 1907, and the question is at the present time being actively canvassed once more.

How stands the matter, then? We know now all that we are likely to know until a trial heading is run from shore to shore. We have covered, counting the two opposite sides of the tunnel, a tenth of the entire distance. Engineering opinion is favourable, almost without qualification to the scheme considered only from its engineering aspect. The soundings and borings and samples taken show that the chalk measures on both sides of the Channel are as one. There appears to be the same character running right from shore to shore, the same thickness, the same density, the same chemical properties. There is nothing to make us believe that cracks exist in the chalk or that the latter is permeable by water. It lies at a convenient depth beneath the water, and can be easily cut. Perfect success was attained by the plant employed for the old galleries now existing, but since that date tunnel-boring has been reduced to a fine art, an exact science, and there is not a shadow of reason for our engineers not carrying the scheme through in triumph, unless, of course, something wholly unexpected and geologically unthinkable should be discovered far from shore. The chalk then, is an admirable medium. It would not require timbering, but would be capable of supporting the strain imposed from above; and there is no evidence to point to need for any excessive pumping.

Details of the Scheme

All, then, is favourable to the making of a tunnel beneath the waters which make us an island, a jewel in a silver sea. The tunnel would in reality be two tunnels. The main gallery, during construction, would be supplemented by a second, communicating at one or two points with the primary. This would serve for drainage and ventilation, and eventually would form the permanent second tunnel, so enabling trains to proceed simultaneously upon different lines. The tunnel would be 30 miles in length, and the latest proposal is that, just as illustrated at the Sangatte end, the line on the English side shall terminate in a long open horse-shoe viaduct, which could be swept by the guns of our fleet as well as from the land. This safety valve would be employed, of course, only in the event of invasion.

Further precautions would take the form—supposing the recommendations laid before a Commission of the eighties were adopted—of a system whereby the tunnel could be blown up or flooded with water by the touch of a button either in Dover Castle or in the Admiralty offices in Whitehall. From the same coign of vantage it would be possible to charge the tunnel with deadly gases But, although France has never abated her enthusiastic advocacy of the plan, although she is willing to agree to the most rigorous safeguards on our side of the water, although the tunnel scheme has been approved again and again —and as often disavowed—and although the work has run forward, all told, to the extent of 2½ miles, we are still at present little nearer completing the work than we were before Sir Edward Watkin began his soundings and borings and inaugurated a giant burrow to undermine a sea.

Whatever the outcome, the scheme is fascinating, a page of Jules Verne in real life. If carried out it would be the biggest thing in submarine engineering ever attempted in the history of the world. We have many fine subaqueous tunnels, but no one has as yet succeeded in worming his way beneath an arm of the sea such as this. The train ferry still holds the sea against the tunnel, but is in fact no nearer realisation than the tunnel. Both are as high in the clouds as that titanic scheme, which was once declared likely to fructify, a scheme which was to make the Panama Canal unnecessary. That was not a train-ferry, but a ship train. We were to have a railway across the Isthmus of Panama. Its trains were to pick up the biggest liners and scurry off with them and all their cargo bodily by the route that Raleigh followed when he was first saw that silent sea in which, he prayed God, he might be spared to sail in an English ship. The train-ferry and the ship-train and the Channel Tunnel are all dear to the young engineers who dream dreams, and loom in the rainbow reveries of the veteran engineers who see visions. But the tunnel is to this extent ahead of the other schemes, that it is 2½ miles dug.

The French Entrance to the Tunnel at Sangatte

It is proposed to have a viaduct linking the shoreward end with the main tunnel, in order that the connection may be broken easily in time of war

THE SUPPRESSION OF THE SLAVE TRADE

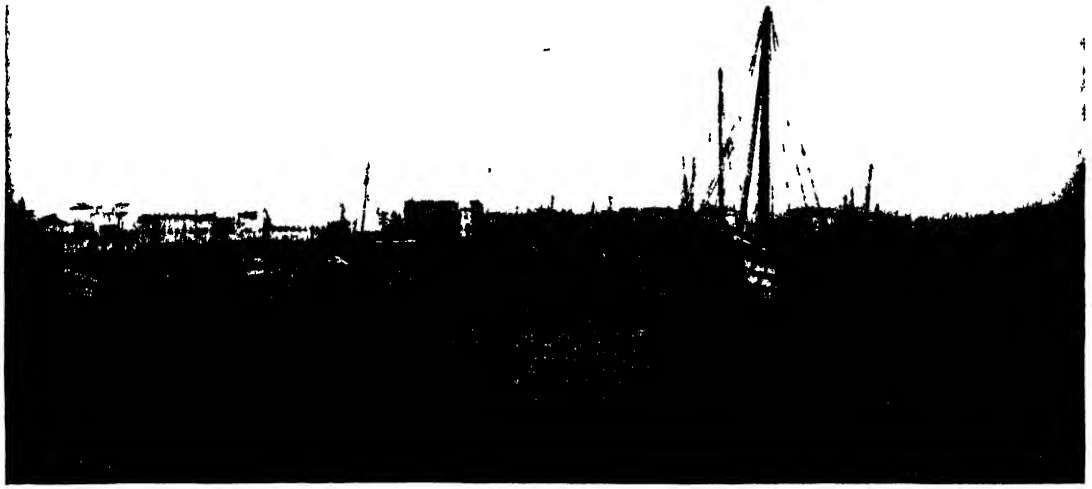


Photo taken by Sir John Kirk, G.C.M.G., in 1884

Arab Dhows in the Harbour, Zanzibar

IT is difficult at first to believe that a hundred years ago the slave trade had only just been theoretically forbidden by Great Britain, Denmark, and the United States, and that actually it was raging all over Africa. In 1813 or 1814—in fact, in any year before the conclusion of the Napoleonic wars (after which resolute naval action was taken by Great Britain to put down the over-sea transport of slaves between West Africa and America)—this traffic in human beings was being carried on to an extent unparalleled in history, for the recruitment of labour to cultivate the soil of North, South, and Central America, and, in the Old World, to supply Morocco and the Barbary States with soldiers and servants, and the Empire of Turkey with eunuchs, soldiers, and domestics of all classes. Similar demands were being supplied in Southern and Eastern Arabia, Southern Persia and Western India. In South-central Africa slaves were being recruited for the cultivation of plantations in Angola and Sao Thomé, in Central Africa for dispatch to Arabia and Persia, but still more for the cultivation of the coastlands under the dominion of Zanzibar, and for the plantations of the Portuguese colonies of Mozambique and Zambesia. Slaves were amassed by the conquering Zulus either for inclusion in their armies or for sale to the Portuguese. Slaves were being sent in large numbers to Madagascar, where they were eagerly purchased by the Malagasy chiefs; and, after the Napoleonic wars were over, to the French colony of Réunion. Thousands of slaves, also were being purchased in Mozambique and Angola for dispatch to the Dutch and English settlers in Cape Colony.

All the slaves referred to in the foregoing paragraphs were of negro race. They included perhaps a few negroids, such as the Fulas of West Africa, Galas or Abyssinians; but as a rule it did not pay to enslave peoples of other than negro race in Africa. With any large proportion of Caucasian

A Crowd of Slaves Released from a Slave-Trader's Stronghold in Central Africa

(Drawn by Sir H. H. Johnston in 1899)

The Nyasaland slave trade was not really abolished until from one cause and another, the British were led to invade and conquer Central Africa. Between 1889 (when Sir H. H. Johnston laid the foundation of the Protectorate of British Central Africa) and 1905, the slave trade between Tanganyika, Nyasa and the lower Zambezi came to an end

blood, the captive refused to be a slave, either committed suicide, fought for his life, or attained his liberty.

Slaves who Founded Dynasties

But, of course, at that period—a hundred years ago—slavery and the slave trade was not confined to Africa, Western Asia, and America; a considerable amount of enslavement was going on in Central Asia, and a small amount in Malaysia. The Central Asian slave trade was in some aspects of too infamous a character to be described in these pages. It was carried on chiefly by the Turkish or Turkoman clans of Bokhara, Khiva, and of Western Tartary, Northern Persia, and Afghanistan. The victims of this trade were chiefly tribes of Persian or Kashmiri race speaking Aryan dialects, and the vaguely defined "Kafirs" of the Indian borderland. The Indian peoples did not scout the notion of slavery, and were quite ready to buy Afghan, Persian, or Turkic slaves, Abyssinians or negroes from East Africa. Many of these slaves rose to high positions in India, and even founded dynasties! In the Caucasus Mountains the Georgian and Ossetian tribes were quite willing to sell their daughters to the Turks; but the slavery of the Circassian concubine was seldom a hard one, and little other than marriage by purchase. The Central Asian slavery and slave trade were finally extinguished by Russia in the latter part of the nineteenth century.

The Dutch to a limited degree had fostered a slave trade in Java (though a hundred years ago this was temporarily suppressed by the British occupation) and in the larger islands of Papuasia. The Dutch in the eighteenth century had sent several thousand Malay slaves to work in Cape Colony, where their descendants now form a notable element in the population. After the Dutch had recovered from British control their possessions in the Malay Archipelago they revived or tolerated for some years longer the sale of human beings (even to the middle of the nineteenth century), especially such as were of Papuan origin and closely allied to the negro in physical characteristics. From the opening-up of the Melanesian archipelagoes in the first half of the nineteenth century arose a veritable slave trade, carried on by the British and French in spite of missionary protests. This infamous traffic, known as "black-birding," was intended to supply New Caledonia and the north-east coasts of Australia with coloured "Kanaka" labour. The slave trade of Melanesia was really only abolished about twenty years ago, though of course it was not carried on under such an ugly name, but under various specious disguises.

The condition of the Amerindian peoples of Central America, the West Indies, and South America between the sixteenth and the nineteenth centuries had been virtually that of slavery wherever the lands were ruled by the Spaniard, Portuguese, or Dutch. The British traded in Amerindian slaves down to the middle of the eighteenth century; but they had found it more to their commercial interests from the time of Drake onwards to espouse the cause of the Amerindian against other cruel Europeans, and the British Empire in tropical America largely sprang into existence as the result of this alliance; for the British were helped enormously in obtaining a foothold in Central America, the West Indies, and Guiana by their alliance with such peoples as the Mosquito Indians of Honduras and the Caribs.

A Better Alternative

Slavery—that is to say, forced, unpaid labour, and undue interference with personal liberty—has been an element in human affairs from a very early period. Many thousands of years ago it occurred to some conquering race (as a better alternative to slaughter and perhaps cannibalism) that the women of defeated tribes should be taken as wives, and their children and young men made to work for nothing.

Sometimes whole populations were enslaved by some conquering aristocracy of superior race—that is to say, superior in courage, physique, or cleverness. In time the descendants of these conquerors assumed almost the rank of demigods. The mass of the negroid people of ancient Egypt were held in virtual slavery by the ruling caste of the dynastic Egyptians who were of Caucasian race. In the main these peoples at the present day. The Iberians in their turn were enslaved by the Aryan Kelts, but have left their traces very distinctly in the languages of Ireland and Wales, and in the physique of Ireland and Western Britain. The Kelts were virtually enslaved by the Romans; still more did they become the serfs of the Saxons, while Saxon and Kelt alike were mastered by the Norman French. Conditions of serfdom

Photo by the late Rev George Grenfell in 1892

A Slave Trade Depot on the Upper Congo

dynastic Egyptians were Hamites, that is to say, akin to the Gala and to the ancient peoples of Southern Arabia, or they partook more of the Libyan or Berber type. Again and again in the history of Europe we discern by archæological evidence or by written records, invasions coming from the north or east which enslaved the peoples of the Mediterranean or of Western Europe. Our own land has frequently been enslaved in its ancient history. The Iberians of the Mediterranean (then, it may be, a race of Central Europe) displaced and enslaved earlier populations of Eskimo or negroid type, some traces of which remain in our —that is to say, the holding in subjection and virtual slavery of the masses of the people by an aristocratic caste—continued in England and Ireland down to the fourteenth century, just as they did in Russia till 1860.

The Spanish discovery and occupation of tropical America led to an immediate enslavement of all the Amerindian races which could be controlled by the Spanish conquistadores. So severe was the work imposed on these Amerindian slaves that they died by the hundred thousand—died off so rapidly that within only about twenty years from the date of the discovery of

America the Spanish Government had to think of some alternative, and chose that of the negro slave from Africa. About 1513 the regular European slave trade with the Africa of modern date commenced. It was at first carried on by Flemings and Portuguese, but the British took a hand in 1562. During the seventeenth century the Dutch did most of the slave trade between Africa and the New World, but in the eighteenth century the lead was taken by England.

But a revolt against the very principle as well as the practices of slavery had arisen in Great Britain as one of the results of the popular upheaval in the seventeenth century against tyrannical government. Under the Stuart restoration the Quakers and the early Nonconformists set their faces steadily against slavery and the slave trade. They were soon followed by outspoken clergymen of the Church of England. The matter was taken up in Germany by the early Moravian missionaries, and splendidly supported by the Huguenots who had been expelled from France. Many of these Nonconformists, Quakers, Huguenots and Moravians, through persecution in the Old World, had to make a home for themselves in North America. There the anti-slavery propaganda was carried on with vehemence and acumen. During the last half of the eighteenth century a stronger and stronger anti-slavery party grew up in Great Britain itself. Despite the opposition of the Crown (for George III. and two of his sons were strongly in favour of slavery and the slave trade, though others of his sons, including Queen Victoria's father, the Duke of Kent, worked as vehemently for abolition), the House of Lords, and the Chambers of Commerce of certain great cities, popular feeling carried the day, and in 1807 the slave trade was declared illegal. In 1811 it was penalised, and in 1834 the status of slavery itself had been entirely abolished throughout the British dominions. But France had vacillated a good deal. In the first outburst of revolutionary reforms slavery had been abolished, but Napoleon I. reinstituted it, and then, a month before Waterloo, again declared it illegal. But the French Government, though it professed to condemn the slave trade, did not finally abolish the status of slavery throughout its colonial possessions until the year 1848. Holland was as late as 1863. Spain and Portugal

Arab Slave Dealers of Nyasaland

were the worst laggards. Slavery was not abolished in the Island of Cuba till 1886, nor in the Portuguese African possessions till 1878.

The real bulwarks, however, of slavery and the slave trade were the eleven South-eastern States of the North American Union. So long as they continued to uphold slave labour and to cultivate their cotton and other products by means of negro slaves, there—as well as in Cuba and Brazil—remained markets for African slaves so attractive to ruthless enterprise that the suppression of the maritime slave

trade from Africa was rendered very difficult.

What did the British do—for after the year 1819 we began to apply a portion of our Navy to the resolute suppression of the African slave trade? They maintained squadrons of not very large ships on the unhealthy west coast of Africa. Into these ships as early as 1829 the principle of steam-power had been admitted, so that in chasing slaving vessels the pursuer might not be baffled by calms, currents, or tides. The first head-quarters was the newly founded city of Freetown at the mouth of the Sierra Leone river. Here were landed the slaves set free from the captured vessels. But as the bulk of the slaves were coming from the Niger delta, Dahome, the Cameroons and Congo, a more convenient base of operations was found in the Island of Fernando Po, which nominally belonged to Spain. This basis of operations, however, had to be given up in 1834 owing to Spanish opposition. In the meantime, however, the British had acquired a foothold at Lagos and in the river mouths of the Niger delta. They also made considerable use of St. Paul de Loanda on the Portuguese Angola coast. A good deal was done by negotiations and small conquests to induce the native rulers to abandon the practice of selling and exporting their peoples. Yet the real death-blow to this traffic was delivered by President Lincoln and the victorious Northern armies in the United States. For after the abolition of slavery and the conquest of the South in 1864, there ceased to be any really attractive market across the Atlantic. The former Spanish dominions, with the exception of Cuba and Porto Rico, had become independent republics who preferred a Caucasian type of race and wished if anything to exclude negroes. The humane and enlightened Emperor of Brazil was gradually restricting slavery and discouraging the importation of further negroes; Cuba was fighting for its independence. In all probability, the actual shipping of slaves from Africa to America came to an end about 1877.

Meantime, however, the slave trade—as revealed by Livingstone—was raging in Central Africa. All East-central Africa was being ravaged by armies of negroes armed and led by Arabs for the acquisition of slaves. The slaves were in part required for the carrying of ivory down to the coast, but once arrived on the coast they were sold for work in the various plantations or they were shipped in numbers to Arabia and the Persian Gulf. The British squadrons had first of all patrolled the western Indian Ocean to stop the slave trade between Madagascar, Zanzibar, and the United States, and from 1865 onwards they applied themselves to the suppression of the slave trade across the Indian Ocean. A depot and a guardship were established at Zanzibar, and the Sultan of that island was coerced into signing treaties to abolish the slave trade. Yet the evil was not really abolished until from one cause and another the British were led to invade and conquer Central Africa. It was, of course, the figure of Livingstone that beckoned them thither, Livingstone, whose work was eagerly and gallantly followed by various missionary societies and by Scottish planters. In the eighties of the last century these planters had engaged in a struggle with the North Nyasa Arabs to put a stop to the slave trade which was depopulating that region. In 1889 the British Government intervened. In that year the writer of these lines laid the foundations of the protectorate of British Central Africa. Similar action was taking place in East Africa and in Nigeria. Between 1889 and 1905 vast areas of tropical Africa were brought under immediate British control, and the slave trade in all those regions came to an end, together for the most part with the status of slavery. Similar results have attended the French, German, and Belgian conquests.

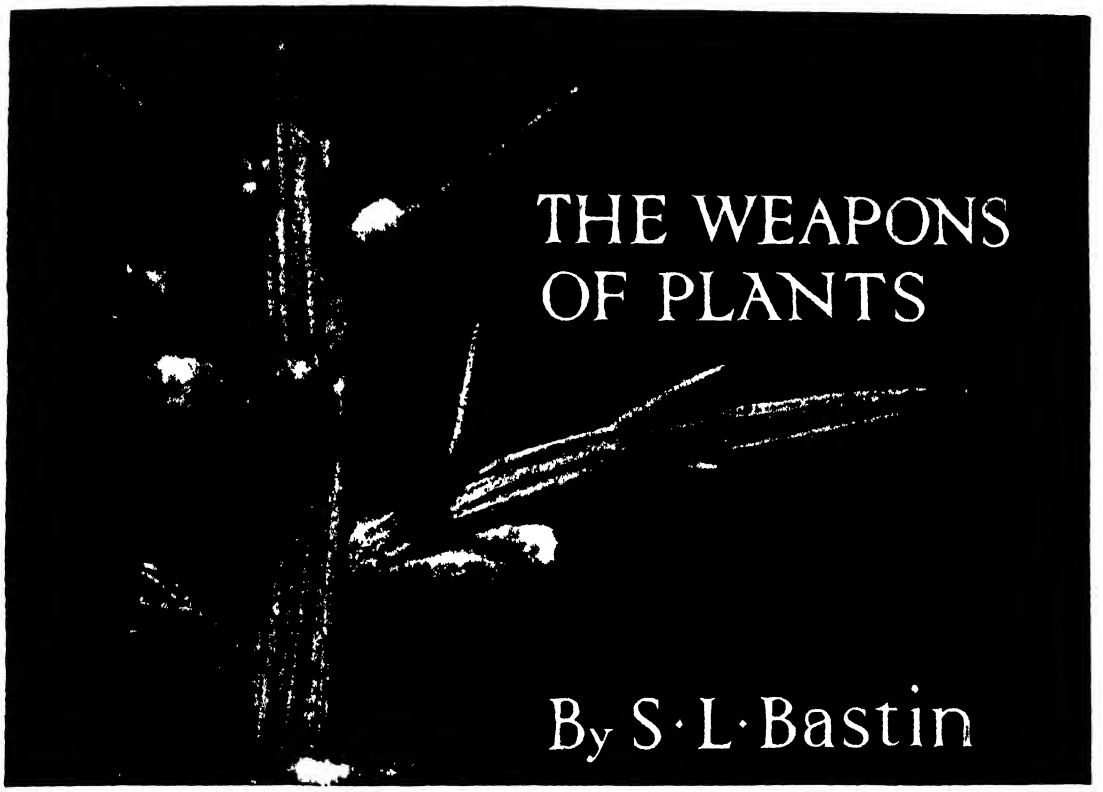


Photo S I Bastin

Bayonets Fixed! How the Furze Protects its Shoots

Are Plants Deliberately Cruel?
The Tortures they Inflict on Animals

ON every side the plant is menaced by a host of enemies. These are so persistent in their attacks that the question of defence is a very important one in the world of vegetation. Now, although the plant cannot take up the aggressive to any extent, the weapons which it employs are of an exceedingly formidable nature. In their way they are quite as effective as anything which the animals employ in their battle for existence.

Many of the methods of defence which have been adopted seem so necessary that they cannot be criticised. On the other hand, some of the schemes appear to involve a great deal of suffering on the part of animals which does not seem quite justifiable.

One of the commonest armaments of the plant is the adoption of some kind of spines. The holly is a rather singular instance of this plan of defence. As is well known, a typical holly leaf is adorned with a number of very sharp spines, which make it a difficult object to handle. The plant is thus well protected against browsing animals. It is very strange to note that when the holly grows into a tree, and produces branches which are more than 8 feet above ground level, the foliage becomes less spiny until at last the leaves have none at all. Of course, the upper foliage is quite out of the reach of cattle, and so no spines are needed. Another common plant which has found the spine to be an excellent means of defence is the furze. Here the whole leaf has been modified into a sharp point. That the gorse in all ways

is one of the best protected plants of the country is seen when we note how completely the young shoots are surrounded by spines. The way in which seeds are protected by spines is well seen in the case of the Sweet Chestnut. Here it would be a very clever animal that could open one of the cases before they split naturally with the ripening of the seed.

There are few plants so well armed as is that when the spines penetrate the flesh of an animal they hold fast. Being fairly easily separated from the parent plant, it is more than likely that the animal will carry away with it quite a number of these barbed spines. These, of course, will probably cause a great deal of suffering to the creature, and it is highly probable that serious wounds will result before the spines are cast off. Even more cruel is the plan

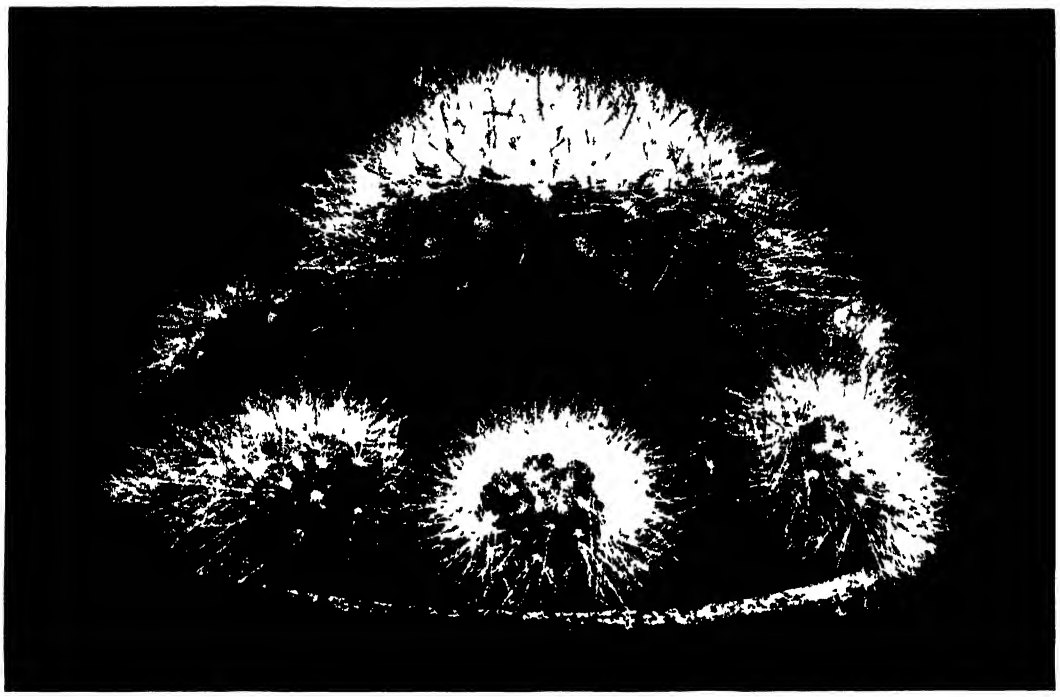


Photo S. I. Hastin

A Well-Protected Cactus

The whole of this plant, which is called the Old Man Cactus, is covered with dense white spines. It would be quite impossible for an animal to make an effective attack

the Cacti. Living as they do in deserts, these species are peculiarly liable to be attacked by thirsty animals. Now, a common mode of defence in the case of cacti is the covering of the plant with sharp spines; the incautious animal simply gets pricked and goes away. With a cruel ingenuity which it would not be easy to beat, some cacti have adopted a plan which seems decidedly brutal. In this case the spines are covered with minute barbs so small as to be almost imperceptible to the naked eye. The result of this adopted by a cactus which has been well called the "wait-a-bit plant." Here the spines are of two kinds. Some are just simply of a pointed nature, whilst others are curved round like a fish-hook. Now any animal which attempts to attack the succulent stem would suffer in two ways. First, its nose would be pricked by the sharp, pointed spines, and its tongue would be caught in the cruel hook. The creature would certainly not free itself without the most shocking injuries.

The spines of most cacti are so arranged

Photo S. T. Haslam

A Vegetable Thug

Few things in the vegetable kingdom are more remarkable than the determined thugs, from the honeysuckle and ivy to the stout, strap-like liana here illustrated, which seize upon and strangle to death other members of the plant world in their efforts to keep a good place in the sun

that they completely shield the juicy stem from any possibility of attack. It is said that on occasion the Mexican ponies will try to knock a cactus to pieces with their heels when they are thirsty. More often than not the animals suffer cruelly for their temerity. In much the same way the Aloes and Agaves are protected, so that a hedge of these plants, when placed round a field, is better than the most perfect barbed wire fence.

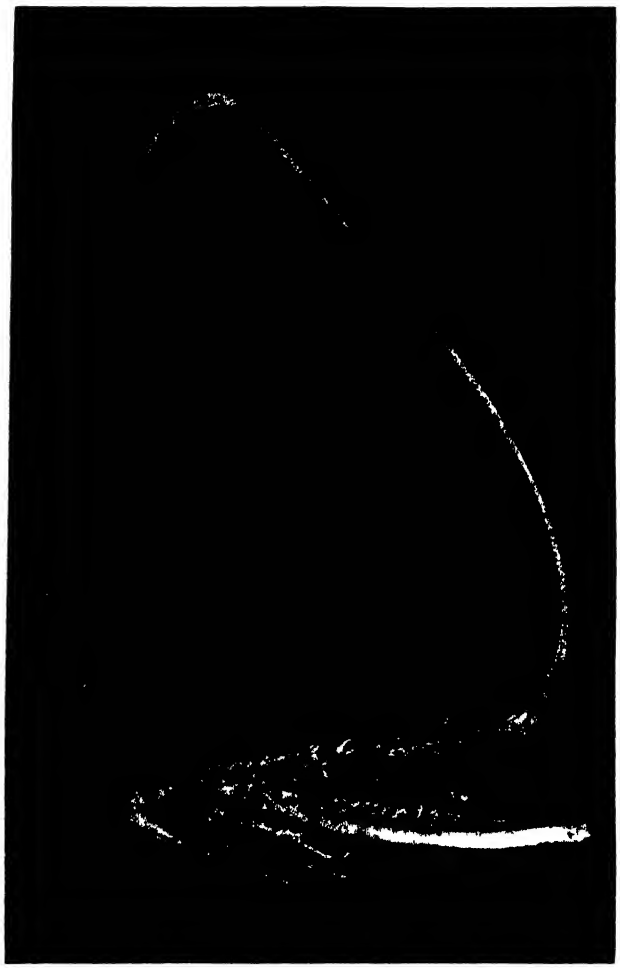


Photo S. L. Bastin

A Plant that Kills Animals

These fruits of the Martynia, a tropical South American plant, attach themselves by hooks, several inches long, to the coats of passing animals. In trying to tear them from their flesh the poor creatures sometimes get the hooks caught in their mouths and die a dreadful death

The poisoned hair is another of Nature's schemes for protecting the plant, and really this seems to be unnecessarily cruel. Of course, the common Nettle is a good case in point. Here we have a fine hair which penetrates the skin; meanwhile, a highly virulent poison is ejected. The results are sufficiently unpleasant, but they are as nothing when compared with what happens in the case of some tropical nettles. An Indian species which grows into a great shrub is with good reason regarded with the utmost dread by the natives. A well-known botanist who had the misfortune to be stung by this great nettle was ill for nine days. During the first few hours the symptoms were most alarming. For hours the sensation was as if the hand which had touched the plant was being rubbed with hot iron; as time went on, the pain involved the whole arm, whilst before the agony subsided a contraction of the muscles of the jaw seemed to threaten lockjaw. A somewhat similar plant, allied to the nettles, is to be found in the warmer parts of Australia. To torture men and animals in this way seems to be a highly cruel proceeding.

A critical examination enables us to see that each hair is hollow, with a bulb at its base which is charged with a most virulent poison. The whole thing acts very much like the hypodermic syringe of the doctor, for the point of the sting readily penetrates the skin and (being slightly broken) allows the poison to flow into the blood. A somewhat different kind of stinging hair is to be seen in the case of a little Primula often grown in greenhouses. The plant looks innocent enough, but an enlargement of a leaf shows that every part is densely covered with hairs. These penetrate the skin when the plant is handled, and at the same time inject a poison which is sufficiently powerful to set up a

most painful rash that may last for days. When we consider what a small amount of the poison must be received into the system it is realised how very powerful this must be.

A rather curious form of defence on the part of the plant is that in which it escapes attack because it is overlooked. A small South African plant (*Mesembryanthemum*) is a succulent which grows in a parched desert, where it would be in great danger of being destroyed by animals. Yet this plant bears such a close resemblance to the stones and pebbles among which it finds its home that it would be a difficult matter for anyone to discover it. Some species of cacti are also remarkable for their rock-like appearance.

Even more strange are those cases in which a plant, destitute of ordinary means of defence, seems to mimic a well-protected species. We have seen how finely armed is the nettle against its enemies, and it is strange to find that there are quite a number of plants which, in appearance, are very much like the well-known weed. Quite the most striking of these is the White Dead Nettle, a plant which in its early days, before the flowers are produced, bears a strong resemblance to the Stinging Nettle. These two plants commonly grow together, and it is certain that the Dead Nettle, which is absolutely devoid of stings, is often mistaken for its troublesome neighbour.

A much more cunning plan of defence is that adopted by the wild Arum. If any

Photo S. I. Bastin.

A Plant that Destroys Lions

The seed vessel of the South African Grapple-plant (*Harpagophyton procumbens*) is provided with a large number of curved hooks by which it attaches itself to the coats or hoofs of animals and thus gets transported from place to place. Sometimes it causes dreadful torture, and has even been known to choke and cause the death of lions

animal should try to chew a small portion of the leaf of this plant the most dreadful inflammation follows. This was formerly thought to be due to some acid poison, but it is now known that the trouble is caused by myriads of minute needle-like crystals in the tissue of the Arum leaf, which pierce the soft skin of the mouth. Very much the same kind of thing, only on a far more terrible scale, is present in the so-called Dumb Cane of the West Indies. Very ugly stories of torture are told in connection with this plant, which, it is said, unfortunate slaves were forced to chew. The lining of the mouth and throat of any animal eating this plant swells to such an extent that speaking, eating, and even breathing may become impossible.

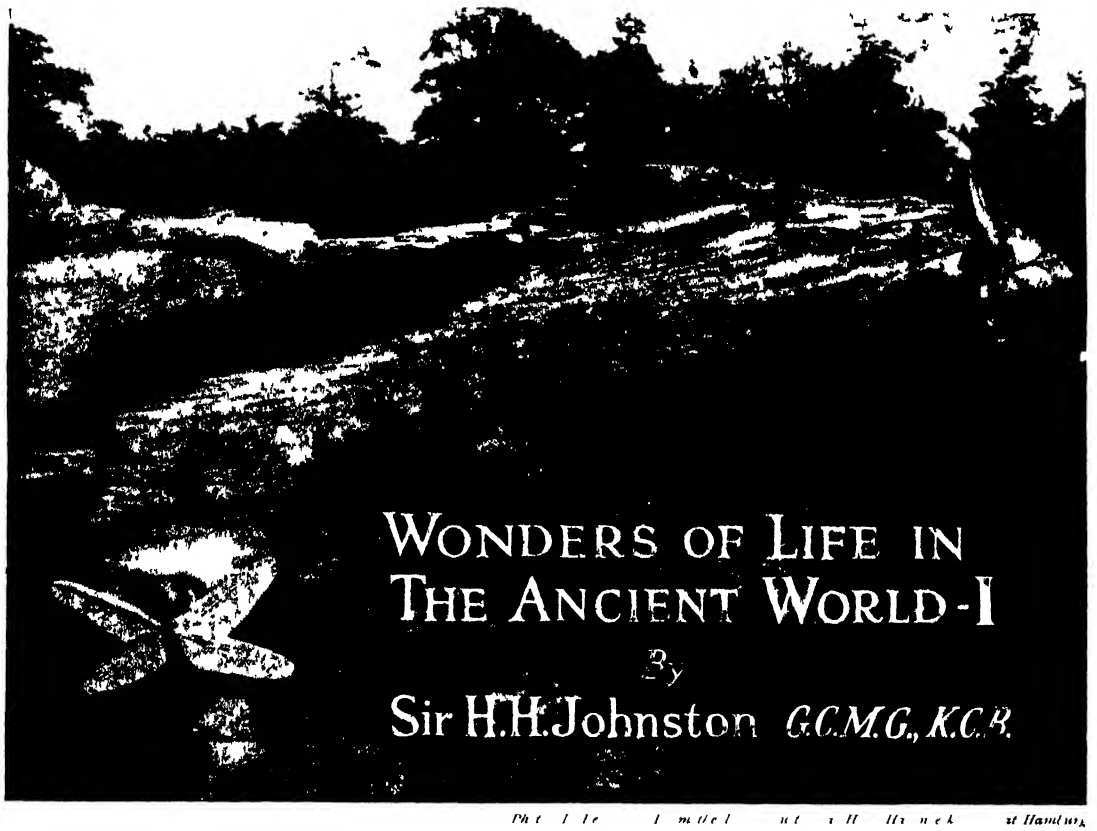
Photo S. I. Bastin

A Well-Armed Cactus

The succulent stems of the cactus are much sought after by thirsty animals in the desert. It is almost impossible to get at them, however, owing to their terrific armament of thorns

The race of insect-catching plants certainly seem to be rather cruel in their methods, but at any rate they make use of the bodies of their victims. Such is the case with all plants which capture insects. The so-called "Cruel Plant" of Brazil is pollinated in its own country by strong humble bees. These robust insects find it an easy matter to push their way in and out of certain little notched slits which guard the way to the masses of pollen. But when the plant is grown in other parts of the world the blossoms are visited by weak insects, such as moths. These creatures thrust in their proboscees to get at the honey and, not being strong enough to pull free, beat themselves to death in a vain endeavour to escape. A British plant, the Avens, was discovered by the writer to be a fly-catcher without reason. The plant produces a clustered head of fruits, to each one of which is attached a hook-like arrangement which assists in the dispersal. Now flies become entangled in these hooks and, when unable to get away, die most miserably.

In considering the question of the dispersal of seed, there are one or two plants which cannot be acquitted of the charge of cruelty. The Martynias of South America produce fruits with hooks sometimes five or six inches in length, which get embedded into the flesh of animals. The African Grapple-plants (illustrated on p. 541) are even worse in the amount of suffering which they cause; thousands of antelopes, goats, and other creatures are lamed by them every season.



A Gigantic Dragon-fly and an Archaic Bird - the celebrated Archæopteryx
Both existing in Bavaria in the early part of the Secondary Epoch

From Fish to Reptile—The "Dragons" of Former Days—
Stegocephalia of the Primary Epoch

SCARCELY more than a hundred years ago began the definite realisation of a series of wonders that have enormously enlarged man's comprehension of Nature and the processes of creation. Until the great French zoologist, Cuvier, translated the discoveries of fossil remains into records, sometimes nearly complete and sometimes faulty, of the existence in past ages of animals differing in some cases from those of to-day, the small world of intelligent people was content to believe that not many thousand years ago the Creative Power of the universe had brought *arbitrarily* into existence the plants, the beasts, birds, reptiles, fish, insects, molluses, and worms, then known to humanity.

Although in the day of to-day fossilised remains have to be sought for as diligently as diamonds or veins of gold and extracted with infinite care and expense from the rocky matrix, the swamp or the river bed, in former times they jutted out from landslips and crumbling cliffs and forced themselves on the attention even of the most barbarous men. In such cases, though they were recognised as bones and skulls, no careful comparison was made, and they were believed to be either the vestiges of giants of former times, or of "dragons." The term dragon seems to have covered not only the remains of Fish-lizards, Plesiosaurs, Dinosaurs, and Pterodactyls, but of an occasional Woolly Rhinoceros or Hippopotamus, while the gigantic bones of

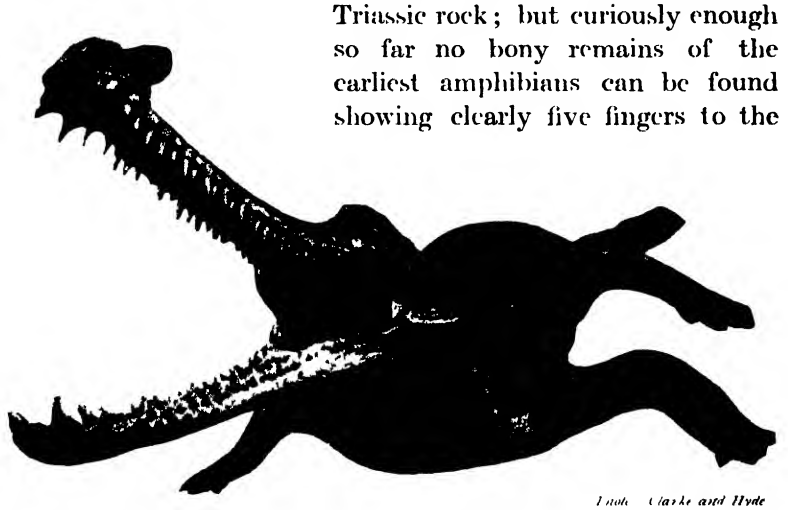
Photo J. Kesmers from the Reconstruction at Herr Hagenbeck's Zoo at Hamburg

The Iguanodon

A huge vegetarian Dinosaur that walked erect upon its hind legs

Mastodons and Mammoths were ascribed to Titans and giants of former days. Indeed, so uncritical were the investigators of two and three centuries ago (terrorised, as they were, by the Roman, Lutheran, and Calvinistic Churches), that when about 1731, a giant Salamander, very similar to the existing species of Japan, was found in the Miocene formations of North-east Switzerland, it was described by Johann Jakob Scheuchzer as a "human witness of the Flood"—one of the human beings of 4,000 years ago, who had been drowned in the universal deluge!

The wonders of Palæontology do not, of course, commence with the record of the Land Vertebrates; but the remains of Ammonites, King-crabs, Scorpions, Insects, Land and Sea shells, and Fish, do not impress the popular imagination with so great a sense of the wonderful as the vanished monsters of the Reptile, Bird and Mammal classes.



A Gharial, from the Terhūt District, Behar, India

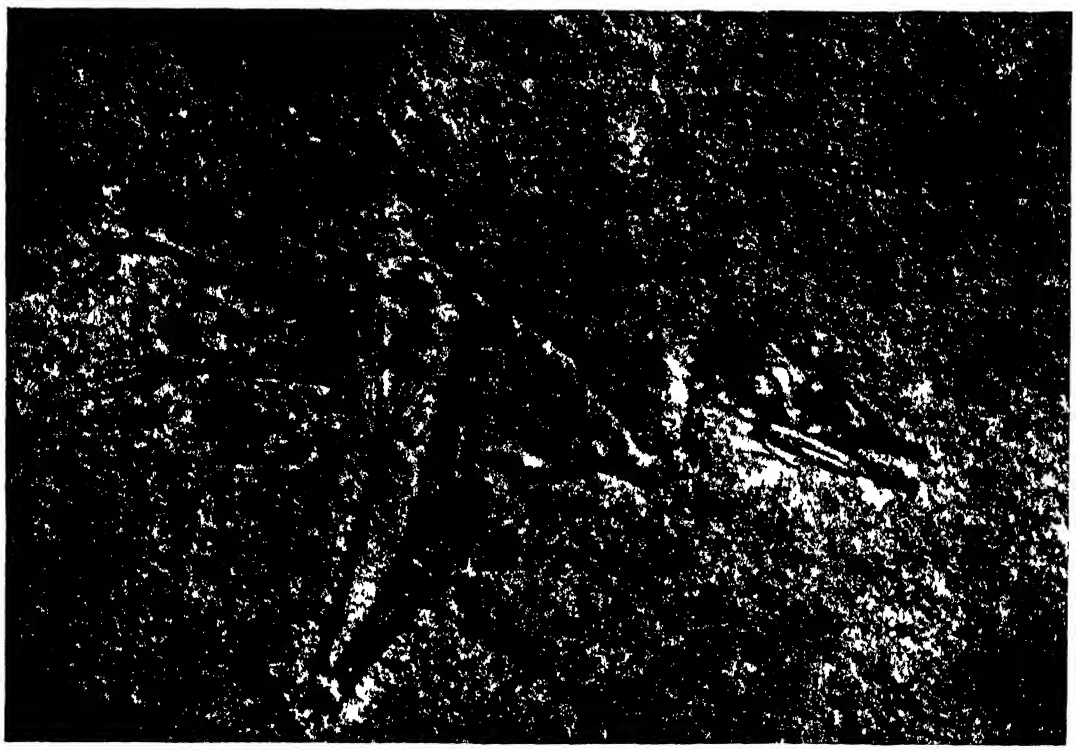
The most noteworthy remains of the Amphibian class, on the border-line between Fish and Reptiles, are grouped as Stegocephalia (from Greek words, meaning "roofed-heads," because the whole of the upper surface of the skull was roofed in by plates of bone).

The Stegocephalia were developed in the beginning of the coal measures of the Primary Epoch. These Stegocephalians show considerable resemblances to two families of extinct Ganoid fishes, of which the modern Polypterus of African rivers is a not far-distant representative. Like them, only in a more marked form, they possessed a small third eye in the middle line of the back of the skull, a median eye which has left traces in the brain and skull of some of the highest vertebrates. The Stegocephalians developed various groups, one of which was apparently limbless and like a foreshadowing of the serpent design. Amongst them was, in all probability, a direct ancestor of the Reptile group, which must have had at least five digits at the extremity of both fore and hind limbs. That there were such five-toed Stegocephalia we may guess from the "footprints on the sands of time," fossilised on the slabs of Triassic rock; but curiously enough so far no bony remains of the earliest amphibians can be found showing clearly five fingers to the hand, as well as five toes to the foot. As we know, in all modern amphibians—salamanders and frogs—there are only four visible fingers to the hand, though amongst the frogs we find cartilaginous vestiges of the thumb, usually covered by the skin.

Strange to say, some of the earliest forms of Reptile of that remarkable order of the Anomodontia (which was not only nearly related to the Stegocephalia, but also to the ancestral mammals), had not only the full five fingers on the fore-limb, but the remains of a sixth or prepollex, a finger in front of the thumb. This prepollex occasionally makes its appearance in "six-fingered" human beings. In the remains of other extinct reptiles of archaic type there seem to be vestiges of even a seventh finger beyond our fifth or small finger. Probably when fish were developing into

amphibians (out of which the perfect reptile quickly grew), the number of their fin-rays (the origin of our phalangeal bones) was considerable, perhaps nine or ten. These soon diminished to seven, and, when the land life was fully confirmed, to five.

One of the most remarkable of the Anomodontia was the thick-set *Pariasaurus baini*, the long body of which was very distinctly elevated from the ground on erect massive limbs, so that the creature walked with its body raised from the ground and not sprawling or wriggling after the fashion of so many reptiles "which go on their bellies." The most interesting sub-order of this group of Anomodonts is the Theriodontia, in which not only does the skull offer some resemblance to that of a primitive mammal, but the teeth are strikingly similar in some examples, being divided into incisors, canines, and molars. Some of these Theriodonts became greatly specialised, in another sub-order, by losing all their teeth, and developing sharp-edged, tortoise-like jaws; or they retained one tooth in the form of a great canine tusk. Reptiles like these Dicynodonts (or Rhynchocephalians—see later) may have been the ancestors of the great Tortoise order, Chelonia, the oldest but one in origin of the existing reptilian groups. But other authorities (perhaps misled by convergent developments) think that the Tortoises and Turtles may have arisen from the ancestors of the Sauropterygia. This was the group which adopted a marine life and developed the extraordinary snake-necked Plesiosaurs of the early part of the Secondary Epoch. From a very primitive reptilian stock not far removed from the Stegocephalians and the most primitive Plesiosaurs (such as Lariasaurus) arose the amazing Fish-lizards, the Ichthyosaurs, which in the middle of the Secondary Epoch occupied in the scheme of creation the place now held by the Whales and Tortoises, leading a life purely aquatic



A Tiny Fossil Pterodactyl, from Bavaria

(they would have been as much unable to exist on land as the Whales). The Ichthyosaurs did not lay eggs but, like many other types of reptile, ancient and modern, were viviparous and gave birth to living young.

From out of the Rhynchocephalian ancestors of the modern Sphenodon of New Zealand there evolved some of the most extraordinary reptiles of an extraordinary class. Some of these, like the Naosaurus, developed the neural spines of the vertebræ along the back into bony processes that must have supported a shield like a gigantic fin. In some species these bony spurs branched into teeth and spikes.

Another Rhynchocephalian reptile of ancient times (*Hyperodapedon*) had a short and broad skull, and only a few grinding teeth at the back of its mouth, but the front bones of the upper jaw were united into a huge curved, parrot-like beak. Some of these Rhynchocephalians (represented at the present day by one living survivor, the Tuatera or *Sphenodon* of New Zealand), suggest steps in evolution which may have led to the Tortoise and Turtle order. This well-marked division of modern reptiles is of extremely ancient origin, and in its differential forms may go back to the very beginning of the Reptile class. The order has been in existence in its present types from the Triassic period. It has seen its best days, like all other reptiles. It once developed gigantic horned Tortoises in Australia and India. The Australian forms of the genus *Miolania*, only died out within the human period. They existed even on the tiny Lord Howe's Island 400 miles out in the Pacific from the Australian coast, and some of them had skulls which measured transversely from the tip of one bony projection (" horns ") to the other, nearly two feet.

Spoonbill Dinosaurs (*Hadrosaurus mirabilis*)

The Allosaurus

A carnivorous Dinosaur feeding upon another monster it has killed

Photos: T. Reimers. From the Reconstruction at Herr Hagenbeck's Zoo, at Hamburg

The Giant Stegosaur Attacked by a Megalosaur

In spite of its size and bony crest the huge, herbivorous Stegosaur must have fallen an easy victim to the sharp-toothed, carnivorous Dinosaurs, which were its contemporaries

The Dinosaurs comprised within their order the most tremendous results of reptilian evolution. Some of them betray slight affinities with the ancestors of the Birds. Somewhat early in their evolution they seem to have advanced towards a bipedal progression, walking on their hind-limbs only, and using the fore-limbs as hands. The conclusion that types like *Anchisaurus* were not far from the reptile type that changed into the ancestral bird, is almost irresistible. But the popular imagination is more impressed by size, ferocity of teeth, and extravagant developments of armature than ancestral affinities; and the types of Dinosaur which will haunt the imagination are such creatures as the carnivorous Ceratosaurus, Allosaurus, and Megalosaurus, armed with terrific teeth, bony knobs on the skull, and sharp, curved claws; or the gigantic Sauropods, such as *Diplodocus* and *Brontosaurus*, the huge Iguanodons—walking nearly erect on massive hind legs—or the Stegosaurs, with long arched bodies, short fore-limbs, and very tall, nearly vertical hind-limbs. In almost all cases it looks as though the Dinosaurs had begun their evolution with a tendency to walk on hind legs only, and that much later on several of their groups had again taken to a four-legged progression, but as a reminder of their past, always had the hind legs much longer, thicker, and better developed than the fore-limbs.

Of all the reptile orders the two most isolated (so far as we understand the history of their origin) are the Tortoises (already dealt with) and the Pterodactyls, or Flying-reptiles. The evolution of this last order is one of the unsolved mysteries in biology. So far the rocks have not yielded the slightest indication as to the affinities in origin of these reptilian Bats, the Pterosauria. Their resemblances to birds are only brought about by their similar mode of life: and it need hardly be said that

Photo Walter I Beasley

The Jaws of a Great Shark of the Eocene Period

This reconstruction of the jaws of an 80-feet long fish was made at the American Museum of Natural History The 200 teeth are the actual fossil remains found in the phosphate beds of South Carolina

their comparison to bats implies no relationship whatsoever with this specialised development of insectivorous mammals. In the case of birds, the fingers of each hand have been reduced to three in number, and even in the most archaic bird are not remarkably long; but from the outer edge of the finger bones, and from the outer edge of the upper arm bones, have grown in course of time scutes (such as we see on the outer edge of the crocodile's forelimb), which have developed into quill feathers, and so provided the bird with a flying surface.

With the Pterodactyls, however, four at least (some palæontologists think that the bony process or spur which bends back from the wrist to support the wing membrane is a diverted first finger; if so, the Pterodactyls are five-fingered), of the original fingers have been retained, but the first three or four remain short, whilst the fifth (our little finger) has its bones developed to an extravagant degree; and these immensely lengthened phalanges serve as the principal support of the bat-like wing membrane which stretches from this outermost finger of the hand to the bones of the leg and tail. The earlier Pterodactyls retained long, sharp teeth and usually developed a very long tail, but they were none of them of large size.

The Pteranodon

In North America, however, there was evolved during the last half of the Secondary Epoch—reaching its culmination just prior to the commencement of the Tertiary or mammalian age—the gigantic Pteranodon, which had a skull nearly three feet long and a wing expanse, possibly, of eighteen feet. The largest genus of this group was toothless, with the jaws prolonged into a stork-like beak, and the back of the skull developing a huge bony projection. Some of the European allies of th s monstrous flying reptile retained teeth in the jaws, others, like the American Pteranodon, were toothless.

The Gharial

The order of the Crocodiles developed at the close of the Trias from out of the Rhynchocephalia stage, when the ancestors of the Dinosaurs were specialising from the same origin, and perhaps those of the Birds likewise; for there are a few points about Crocodilian anatomy and external features which suggest avian affinities. Very far back in their evolution crocodiles repeatedly developed along two lines of skull formation—the long and attenuated snout, and the broad, even short, head. The long-snouted forms, like the modern Gavials (and the Gavial, or, as it should be spelt, Gharial– is of very ancient type) adapted themselves to a life in deep rivers or shallow seas and fed wholly on fish; while the broad, short-headed crocodiles of ancient days led a more terrestrial life, and apparently lived on the early mammals and smaller reptiles of that period. One such type—*Notosuchus*—with its long canine teeth (only one on each side) is very suggestive in appearance of the Theriodontia or mammal-like reptiles, a case merely of convergence and not of affinity. Convergence is possibly the explanation why the modern Gharials (*Gavialis*) are so like the slender-snouted crocodiles of the Secondary Epoch. It is more probable that the modern Gharials, together with their intermediate forms, and the broader-snouted crocodiles and alligators, are all descended from a common ancestor which existed in the closing periods of the Secondary Epoch. During early Tertiary times, True Crocodiles and Gharials were far more widely spread in distribution than at the present day. Gharials very little different from those of modern India flourished in Sussex and Hampshire, so also did actual alligators, which were once numerous in the lakes of the Thames on the site of London, as well as in France and Germany. One of the extinct Gharials of N. India was nearly 50 feet in length.

The ancestors of the Squamata, or Lizards and Snakes, were comparatively modern

Photo: Illmers. From the reconstruction at Herr Hagenbeck's, c/o Hamburg

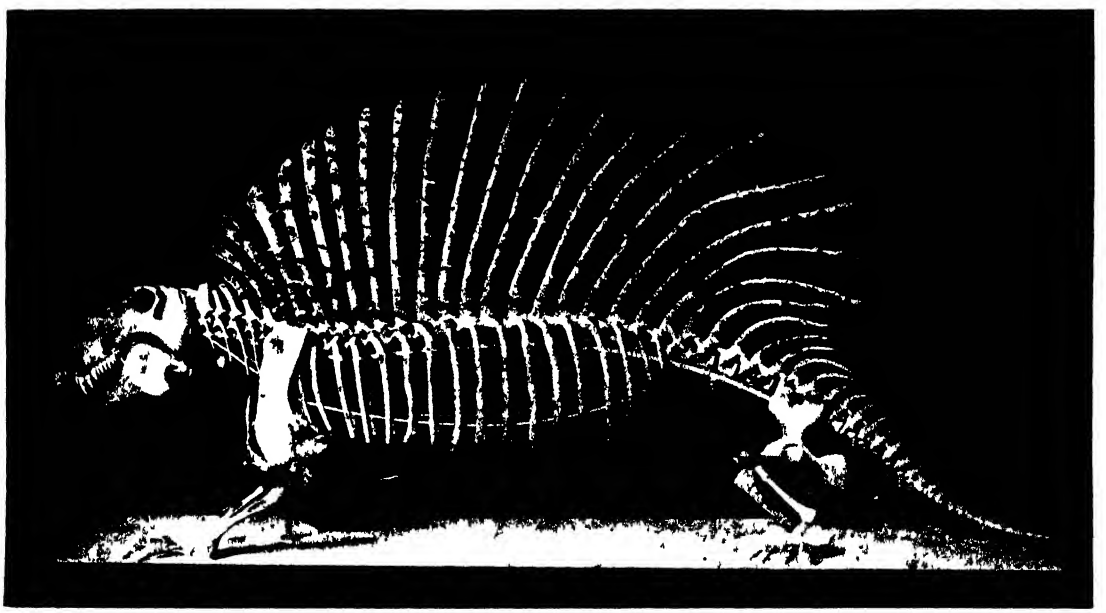
The Pteranodon

The largest of the ancient flying reptiles, a native of western North America

developments of the reptilian class, at any rate, so far as their present geological record is concerned. They arose from out of the Rhynchocephalia in the last quarter of the Secondary Epoch, and in their multiform developments frequently exhibited the tendency to grow to great length, and shed their limbs; in fact, the "snake" principle was constantly at work in lizard evolution.

Limbless lizards, apart from modern snakes, have again and again developed out of four-limbed ancestors, chiefly in connection with aquatic habits. Such types as the Pythonomorpha imitated the Plesiosaurs and the Ichthyosaurs, and evidently took their place as they died out in the Cretaceous period. Their limbs were modified into paddles, and they developed sclerotic (bony) plates round the eye. Of such was the remarkable *Mosasaurus* genus of Belgium and Holland, the largest species of which was more than forty-five feet long. Aquatic lizards of this type also existed in North America, completely adapted to a fish-like life in shallow seas; and if there really are "sea-serpents" still existing, they probably belong to the Mosasaurian family.

The True Lizards of the sub-order Lacertilia, though small animals to-day—the largest belonging to the Varanus group, and attaining a total length of about six feet—have also had their gigantic developments. A Varanid lizard, not unlike the existing monitors, was developed in North-eastern Australia within the human period, which reached to a length of over thirty feet, and must have been a very dangerous animal to ancestral man, if it was also found in those days within the area of human migrations.



The Skeleton of a Naosaurus, a Rhynchocephalian cousin of the living New Zealand Tuatera

This remarkable skeleton (recently added to the collection at the American Museum of Natural History) is that of the Saurian described on page 547. It existed in the first half of the Secondary Epoch. It must have measured 8 feet in length

The Stupendous Ruins of the Vihara at Boro Budor

The Hill Temple at Boro Budor

The Most Wonderful of Buddha's Monuments

NEAR the confluence of the Ello and Progon, in Java, stands a ruin which ranks among the architectural wonders of the world. Of all the temples erected in honour of Buddha this splendid monument, which is referred by Javanese chroniclers to the seventh century, is the most magnificent. Indeed, it is claimed that even the labour expended on the building of the Great Pyramid of Egypt "sinks into insignificance when compared with that required to complete this sculptured hill-temple in the interior of Java."

It is hardly accurate, perhaps, to describe Boro Budor as a temple. It is really a hill some fifty yards in height, the surface of which has been hewn out and built up with mighty blocks of lava to form terraces, which arise tier above tier. At the summit stands a main dome, around which are grouped sixteen smaller, but otherwise similar structures. The hill-temple covers some nine acres. It is, of course, pyramidal in form, the sides at the base measuring 497 feet each. It is richly ornamented with statues, figures of Buddha, scenes from his life, and representations of battles, processions, chariot races, and other designs.

It is probable that the founder of Buddhism, who is known by the various titles of Sakyamuni, Gautama, Buddha, Bhagavat, and many others, was an historical character, an actual prince, named Siddhartha; though, as a matter of course, fables and myths have gathered about him till he has become almost as legendary as King Arthur. According to the main lines of the story, Siddhartha, at an early age, perceived that it was a bad thing to have been born; yet, on the assumption that the human life is merely one in an endless series of existences, it was not clear how the trouble of existence could be escaped. The practice of asceticism did not help him; but Contemplation brought knowledge. Since Evil and Pain are the result of Ignorance, Knowledge brings deliverance from them. As Evil

and Pain are conditions of existence, the perfecting of Knowledge involves Extinction or complete *Nirvana* (blowing out). Apparently the Buddhist Nirvana does mean actual annihilation, not absorption into a World-Soul. But Gautama combined this gospel of annihilation with a singularly high and tender ethical code, which in many respects approximates strangely to the ethics of Christianity, insomuch that it was at one time supposed to be a product of Christian missions. The practice of this moral code is one of the means to the ultimate attainment of Nirvana. Till Nirvana is attained, reincarnations continue. They may take place on earth, for the normal span of life, human or animal; they may be in hell or in heaven—in either of which cases the normal span extends to a cycle; but each reincarnation comes to an end, and is followed by a new one—unless Nirvana has been attained.

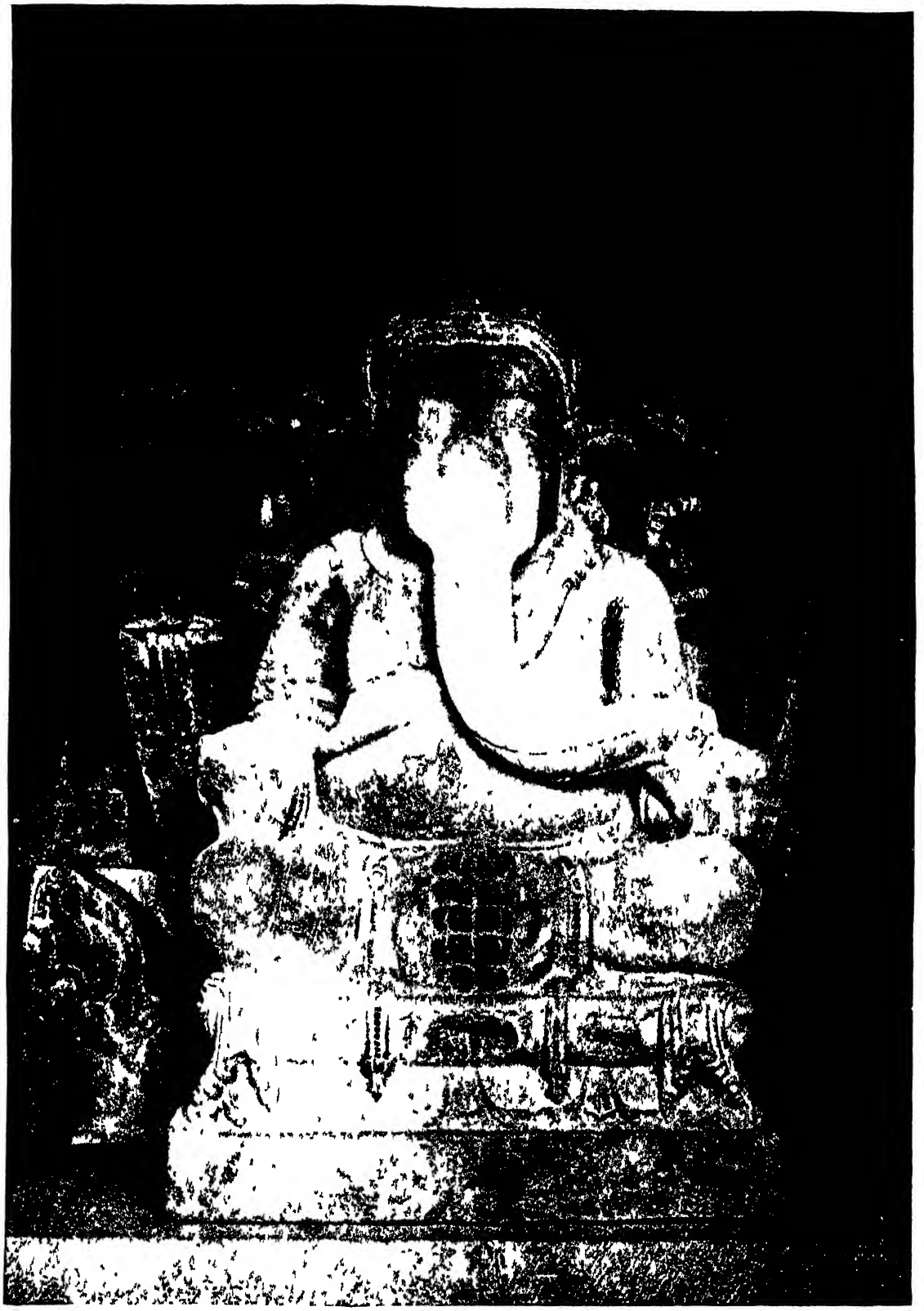
However unsympathetically one may feel disposed towards the tenets of Buddhism it is evident that a creed so rich in material for poetic imagery affords scope to the artist for an infinite variety of allegorical representations. There is not phase of Gautama's teaching which is not represented in stone at Boro Budor.

It is difficult to institute a comparison between this wonderful temple and one of the pyramids, since the mere height or area covered by the former cannot convey any idea of the work which must have been expended upon it. Again, a pyramid is a solid construction, of which the prime object is to outlast milleniums; the other is a temple built and lavishly carved and decorated to do honour to the great Gautama. Just as the pyramids surpass the Vihara in height and area, and in the size of the monoliths employed as building material, so the temple surpasses the Egyptian monuments in decorative elaboration, in its three miles of alto and bas-reliefs, and in its hundreds of statues. From base to summit every yard of the great temple is intended to instruct the climbing devotee in the details of his religion, which is progressively revealed as the summit is approached, until finally the pilgrim finishes his journey before a statue of Buddha. The latter is intentionally incomplete, as if the skill which raised this enduring monument quailed before the task of portraying one so perfect.

Photo Underwood & Underwood

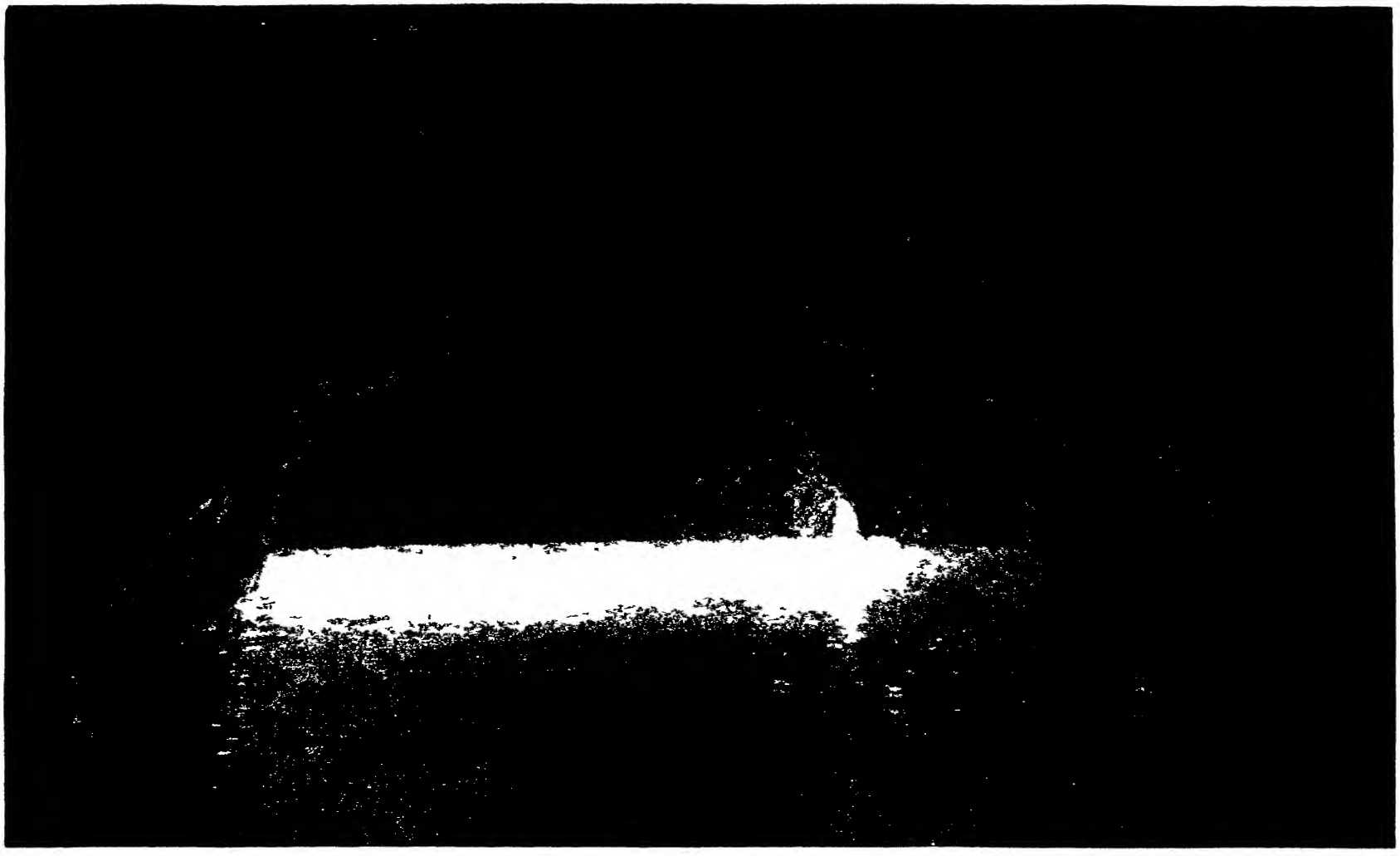
A Leaf from the Buddhist "Bible"

A portion of the three miles of sculpture on the Javanese temple, on which is carved, that all may understand, the sacred stories of the Buddhist creed



The Carved Ganesha at Boro Budor

In Hindu mythology Ganesha is the god of wisdom He is overlord of the lesser gods that wait on Shiva The pious take care to propitiate him before commencing any important undertaking



The Blue Grotto at Capri

The cavern, which is entered from the sea, is 118 feet long and 40 feet high, with a breadth of 98 feet in its widest part. It derives its name from the wonderful blue reflection of the sun s rays through the water

Photo Underwood & Underwood

The "Transformation Scene" in Cox's Cave, Cheddar

The Scenery of the Netherworld

Dazzling Calcite Wonders—Deep Snow Chasms—Vast Halls of Eblis

By E. A. BAKER, M.A., D.Lit.

Author of "Moors, Crags, and Caves of the High Peak," &c.

THE scenery of the netherworld is of two or three distinct types, to which there is little on the surface of the globe to correspond. First come the dazzling wonders of the calcite incrustations—the principal feature of the ordinary show-cave. Fragments of stalactite can be seen in museums, but they give not the feeblest impression of the lustrous beauty of a snowy pendant starting out of the dense shadows in a cave. Nor can the photographs illustrating this article—taken as they are under the worst conceivable conditions, with an incredible expenditure of toil, money, and even personal risk—render the exquisite beauty of colour and the sparkling reflections which are such a charm in the caves themselves. Fortunately, there are caves where anyone can see samples at least of these things in all their pristine loveliness. The Cheddar caves are as easy of access as the museums where the broken specimens are exhibited, and large parts of Stump Cross Cavern, with its pillars and arcades of the most immaculate and purest white, and of Ingleborough Cavern, both in Yorkshire, can be viewed with almost equal ease and comfort. In Ireland a popular resort is the newer of the Mitchelstown caves, an epitome of both the finest stalactite scenery and the spacious

A Wonderful Stalagmite
In the cave which runs for one-eighth of a mile into limestone cliffs on the south side of the Grand Canyon of Arizona

underground halls to be alluded to presently. Of course, there are still more brilliant chambers and grottos beyond the point where the ordinary visitor stops, in all these caves. But, on the other hand, there is no reason why Lamb's Lair, in Somerset, containing the biggest stalactite chamber in England, should not be rendered easily and safely accessible; and it is to be hoped that some day the newly discovered series in Wookey Hole may be opened out. In Lamb's Lair, the gamut of colour, due to mineral deposits, in the fantastic incrustations covering walls, roof, and floor of a cavity 100 ft. high, is rich beyond description; and outside the great chamber there is the Beehive, a symmetrical mass of polished stalagmite unsurpassed in size in this country. None but the hardened explorer, however, is likely to set eyes on the luminous sheets that drape the walls, the stalagmite bridge and terraces, and the wealth of fairy pendants, adorning the finest part of Swildon's Hole, 300 feet below the surface.

Our English displays of stalactite marvels are exceeded in size by the lofty crocketed columns of the Aven Armand and the Minaret of Dargilan in France. Imagine a forest, not of tree-trunks, but of fretted pillars gleaming in crystalline splendour and towering to a height of 40, 60, and 100 feet. The caves of the Dragon and of Arta in Majorca are unique in the bewildering abundance and complexity of the pendulous shafts and tracery reflected in the waters outstretched below, the Lake of Marvels, the Lake of Delights, and Lake Miramar—the largest underground lake in the world. There is fantastic beauty of a special order in the famous Jenolan Caves in New South Wales.

The second chief constituent in cave scenery is the amplitude of the subterranean cavities; and here we introduce a psychological factor, for the feeling of space, the overpowering sense of mystery and potential danger, depend not only on the darkness

of this buried world, but on the personal equation. It is not everyone that can enjoy the thrilling sensation of being swung rapidly down 300 ft. of pot-hole, or overcome the feeling of imprisonment beneath hundreds of feet of rock on a long journey into these halls of splendour beneath the hills. Again, we might ask, take this colossal chamber at the bottom of Gaping Ghyll, roughly equal in height and area to Westminster Abbey: would this be so overwhelming in its grandeur if it were not for the contrast of the wavering light, pouring down with the waterfall, and the impenetrable darkness around? Throw it open to the sky, and would it impress us to the same degree?

But we must take the caverns as they are—vast halls of Ebhs inhabited by the majesty of darkness, which the most powerful means at our command can only partially illumine, savage and solitary, silent as the grave, or echoing everlastingly with the crash of waters. Mystery is an attribute of all, but it is concentrated in a very tangible shape in the unscalable rifts that cleave the rocky hills above the Speedwell and the Peak Cavern, and in the abysmal depths of the pot-holes. Japanese artists, who have discovered fresh sources of inspiration in so many aspects of nature, have found marvellous effects—material for a new species of artistic creation—in their caves of Yamaguchi.

Without any supernatural associations, there is something very terrible and forbidding about certain caves. Most awe-inspiring perhaps of all such grim abysses are the chourums or snow-chasms of Devoluy, in Alpine France, one of which, the Chourum-Martin, is the deepest gulf yet known on the earth's surface. About 100 feet down, an enormous mass of rock almost fills the cavity; and when the exploring party, led by M. Martel, landed on this and attempted to descend beyond, terrible avalanches of snow and rocks began to

Photo E. A. Martel

At Aven Armand

Fretted columns of crystalline splendour tower 40, 60 and 100 feet in height

"THE ORGAN," A FAIRY FOREST OF

No mere photograph can reproduce the exquisite beauty of colour and the sparkling reflections which characteris
of the lustrous glory of the many pendanti

Photo O. Johnson, Pahiatua

STALACTITES AT PAHIATUA, NEW ZEALAND

uch forests of calcite. The fragments of stalactite which can be seen in museums give not the feeblest impression 'hich beautify the world's great caves

fall into the chasm, rebounding from wall to wall, and setting up a violent wind through the disturbance of the column of air imprisoned in the mighty tube. Having reached a depth of 210 feet, the gallant explorers saw that with masses of loose material poised overhead they would be running fearful risks to proceed any farther, and up to the present the Chourun-Martin remains undescended.

The Marble Curtain
A remarkable natural feature at Cox's Cave, Cheddar

Enough stress has been laid already, perhaps, on the third item in the effect of underground scenery—the presence of water, whether in the form of tranquil lakes or of tumultuous torrents like the Recca. The most interesting caves of all are of course those combining all these characteristics. This romantic variety is a feature of several of our native series of caverns. But there is still more of it in some of the Continental water-caverns, such as that of Han, in Belgium, and at Padirac, with its river threading vast fissures where the walls ascend into blank darkness and are curtained and festooned with colossal pendants and weird imageries, under which the explorer, floating in his skiff, is like an insect on the surface of the stream.

The reader must be referred to the photographs for a clear if inadequate impression of these marvels. But there is one kind of underground scenery—if scenery it can be called—which no artist and no camera can interpret—the elemental savagery, the grim physical grandeur of caves like Eastwater, felt rather than seen by the explorer, who is wedged in by rocks that meet like a vice, clings to the face of cliffs scarce seen by the feeble light of a candle, or is suspended over roaring depths where streams tumble incessantly into the unknown. The artist is unborn who can give the uninitiated even a glimmering idea of such sensations.

The Building of a Big Ship

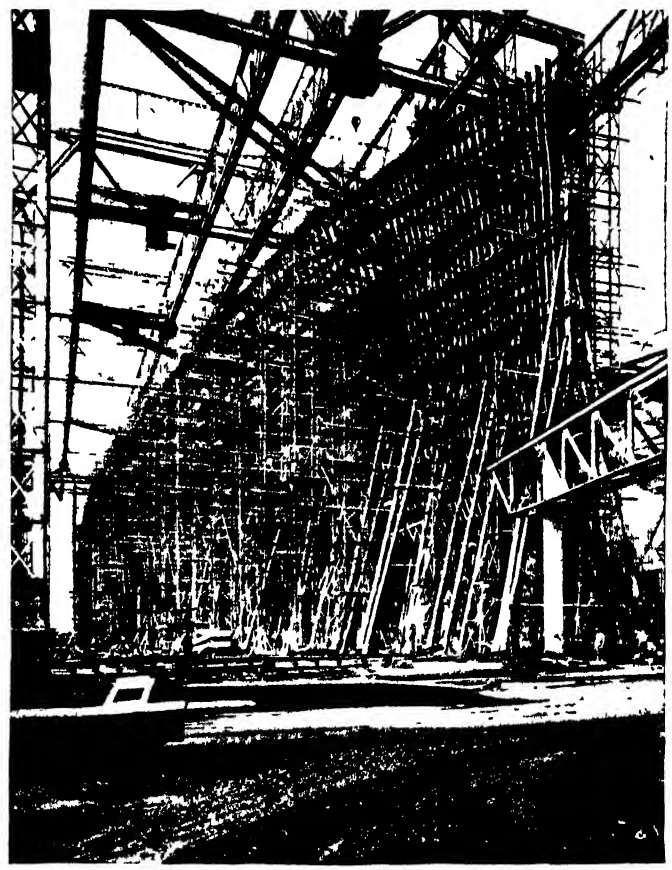
How the Ocean Greyhound is Planned and Constructed

By H. J. SHEPSTONE

IT is no exaggeration to say that there is nothing that man fashions to-day that calls for more skill, ingenuity, forethought, and judgment than the designing and building of a large ship. Be it a great liner that will carry thousands of passengers across the ocean at express speed, in spacious and comfortable saloons, or a mighty battleship with an array of formidable guns, all the knowledge, craft, and cunning that the modern shipwright can display will be needed in the evolving of the vessel. From the time the ship is planned in the drawing loft, till she takes the water at her launching, the brains of learned mathematicians, assisted by the might of complicated and wonderful machinery, and the labour of an army of skilled artisans, have been in constant requisition.

For this reason there is no place so bewildering and fascinating as a modern shipbuilding yard. First there are the building berths. These berths may be enclosed by neat, steel lattice-work walls, or be entirely open. Here the hulls are built up, piece by piece, amid an ever-growing forest of scaffolding. From the overhead girders, that span the site, run cranes that pick up heavy steel plates and beams, weighing many tons, as if they were mere toys, and lift them into the desired position.

Indeed, all the marvels of machinery are here, driven by steam, electricity, compressed air and water. There are the great presses that bend the steel plates into the desired shape and form; machines that



The "Vaterland" on the Stocks

punch holes by the score in them, for the rivets, as easily as you can stick a knife through a piece of paper, while others bite large holes in the hard steel, or reduce the size of the plates by literally slicing off a piece, as deftly and as easily as you

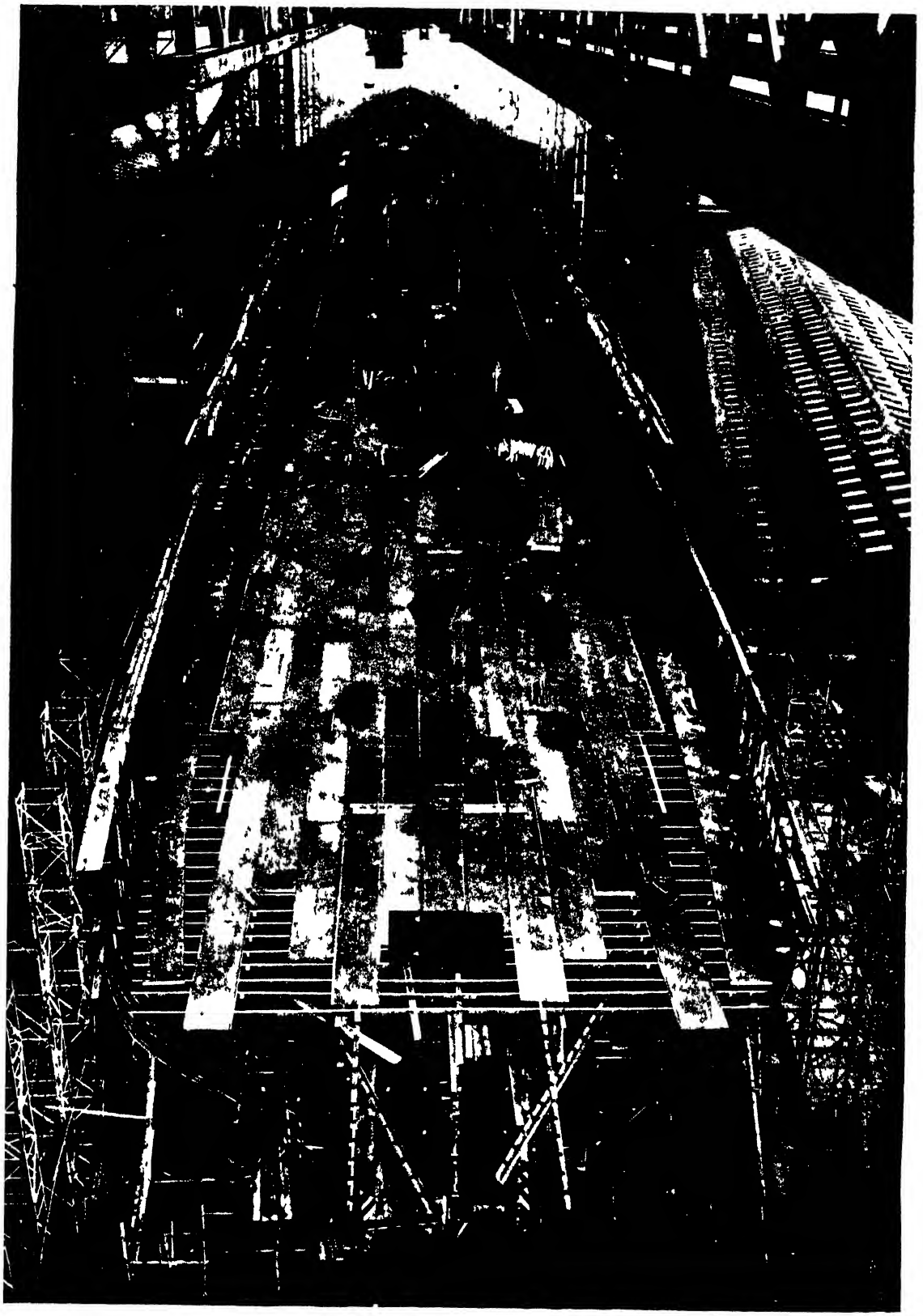
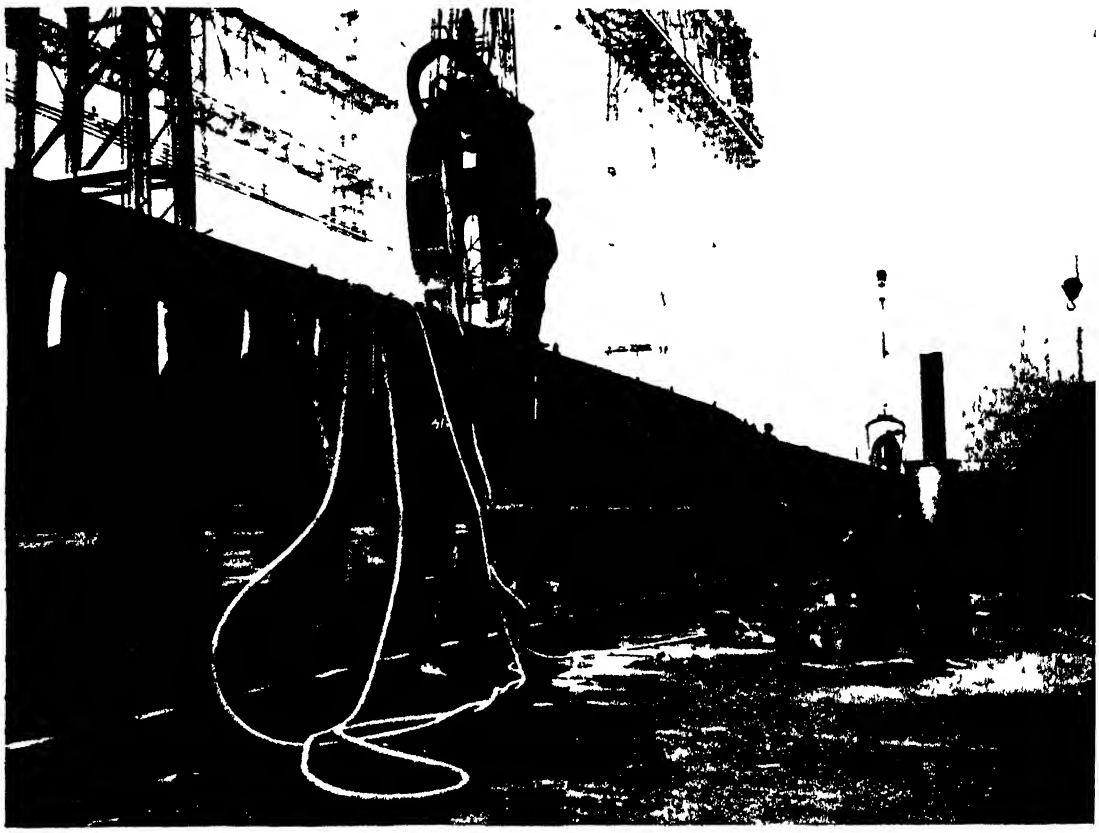


Photo Blohm and Voss Hamburg

Another View of the "Vaterland" under Construction

At the moment this is the longest and largest of liners. She is 950 feet long, 100 feet in breadth, and her tonnage is 56,000

could carve a slice off a loaf of bread. Above all, there is the wonderful activity, the constant clang of the riveters' hammers, the snorting of many engines, the glow of furnaces, the rattle of heavy chains, the shouts of the foremen, the toiling mass of humanity, all creating an ordered chaos the like of which can be found nowhere but at those busy yards by the river banks where great ships are born.



A Hydraulic Riveter at Work on the Vertical Keel Plate of the "Olympic"

Naturally, the men in the yard cannot start upon the ship till it has been planned. This is the work of the draughtsmen, and at all the big yards there is what is termed a drawing or mould loft, an immense room, so large that designs can be made to the actual scale of the vessel. This is necessary if the ship is larger than any existing vessel or of a different type from what the builder has turned out before. In that case the draughtsman, taking the floor of his room as an immense blackboard, chalks out in mighty lines all the girders, frames, beams, and plates. Everything, down to the rivets and rivet-holes, is drawn full size. From these great drawings the working plans are prepared. Then in an immense floor of pine-wood, called the "scrieve-board," the body plan of the ship is cut, from which wooden models are made of her outlines.

From these plans the steel of which the ship is to be built is ordered, as well as all other necessary material. Meanwhile the berth is got ready, and, if the ship is a large one, attention has to be paid to the floor. Before the keel of the *Mauretania* was laid, some 16,000 piles of timber, 13 inches square, and averaging from 30 to 35 feet in length, were driven into the ground. Along the top of these were laid great

Colossal Sheer Legs

The photo shows this species of giant crane (used for swinging boilers and guns on board ship) in Portsmouth Dockyard

beams, and on them again a complete floor of thick plates. Much the same procedure was done in the Vulcan yards in Germany, before work was commenced on the building of the Hamburg-American liner *Vaterland*, of which we show several illustrations. This vessel is the longest and largest of liners, and will take her place on the Atlantic very shortly. She is 950 feet long, 100 feet in breadth, and will have a tonnage of some 56,000.

Now commences the erection of the hull, which is, in essence, a steel box of curious design. Down the centre of the floor are placed portable baulks of wood forming piles from 4 to 5 feet high, and known as keel blocks. It is upon these that the keel of the ship is laid. It is a girder of the strongest kind, as it needs to be, seeing that at one moment it may be in the trough of a wave, deeply immersed fore and aft only, and the next riding on its crest with bow and stern almost out of the water. It has, too, to withstand the terrific blows of ocean billows, which tend to bend it sideways.

The strength of our ship lies in this keel and the centre girder running from one end of the ship to the other. In the case of the *Vaterland* this centre girder, immediately above the keel plate, is 6 feet high, and $1\frac{1}{2}$ inches thick. On either side are other girders, running parallel to it, and from these, at various intervals on both sides, spring the ribs or frames, which curve upwards, and to which the plates that form the sides of the ship are fastened. The ribs are held in place by horizontal rafters or beams that carry the decks.

In the case of the modern liner she is now built with an inner skin. That is to say, there are virtually two hulls, one within the other, carried well up above the water-line. The vessel is also provided with a double bottom, while, as an additional precaution, in case of injury by collision that part of the vessel below the is divided into water-tight compartments

Raising Many Thousands of Tons

(Drawn by J T Jane)

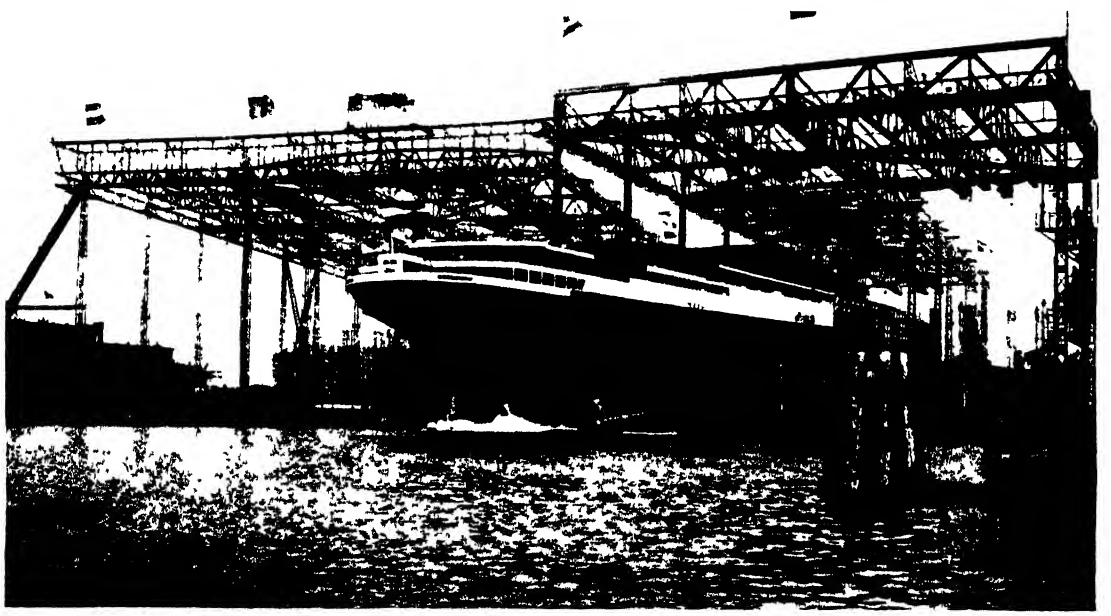
This realistic picture shows the scene in the builders' yard the night before a Dreadnought is launched. By means of wedges she is lifted from the chocks so as to bring her weight on to the greased ways

by means of pillars or bulkheads. In the *Vaterland* there are no less than forty of these, the largest number ever built in a ship.

Upon the ribs or frames of the ship the plates are fastened in strakes, which correspond to the courses of bricks in a wall, or to boards in a wood-covered house. Each strake is composed of a number of long plates joined by their ends. Those used to form the walls of the *Vaterland* are 48 feet long and weigh from 4 to 5 tons apiece. After being bent to the desired shape in the presses they are swung by the cranes into position, and then riveted, this work, wherever possible, being done by machinery. No less than 1,500,000 rivets, weighing two pounds each, were used in the construction of the hull of the *Vaterland*. The port holes in the sides of this ship were not even cut until the plates had been riveted in position, and then they were made by a new process, employing the acetylene torch.

When the riveting is completed, all the joints are caulked, or rendered water-tight, by striking the projecting plate edge till it swells and presses tightly against the plate below. The joints are then tested by water under pressure. In the same way water was pumped into the compartments of the *Vaterland* to test their waterproof capabilities.

The next task is the placing in position of the rudder and the stock on which it swings, the screw tubes, and screws. This, in the case of a modern liner, needs the services of heavy tackle on account of their immense weight. The rudder of the *Vaterland* turns the scale at 90 tons, while the rudder stock weighs 110 tons. Yet it can be swung from side to side with a touch of the wheel, on the bridge, nearly one-fifth of a mile away. Lastly comes the launching. It is interesting to note that the launching weight of the *Vaterland* was no less than 34,000 tons, a weight equal to that of many a battleship.



Phot Koppmann & Co

The "Vaterland" Nearing Completion

No less than 1,500,000 rivets, weighing two pounds each, were used in the construction of the hull of the

Photo Clarke and Hyde

Common Grass Sponges—Trimmed and Untrimmed

Nature's Order of the Bath

Dead Denizens of Forest and Sea-bottom which Assist in Our Ablutions— Whited Sepulchres in the Morning Tub

By N. F. WATSON

NATURE supplies her own corps of Companions of the Bath. Loofa and Sponge both once had life—vegetable and animal respectively. Most of us forget or jumble the fact, and regard the loofa as simply a sort of Turkish towelling manufactured by man, and the sponge as either mineral, vegetable, or abstract. Yet the loofa is vegetable, and the sponge is animal, just as that preternaturally acute philosopher of old—Aristotle—surmised.

The loofa, or loofah, or luffa, is simply a skeleton, the fibrous skeleton of a gourd, known to commerce, from the purpose to which we put it, as the Towel-gourd. We may all see it for ourselves, growing at Kew or elsewhere in one of the sub-tropical houses, a vine-like plant, with green and bulging loofas clustering like aristocratic cucumbers up near the sun-warmed roof. Of course, we are to believe that cucumbers and loofas are not on speaking terms, and both, we may take it, sniff with disdain upon poor common Bryony. Yet all three are cousins, and stand in that degree of relationship to the Mandrake of the Old Testament. Another of their kin is the Bottle-gourd; while, if you peeped beneath the pastry of a pet American confection, you would find yet another there, sliced to make a pumpkin pie. In fact, all the familiar vegetables of the pumpkin and marrow type are related to the scrubbing-sponge by which our flesh is cheered

The Sponge at Work

The currents of water passing from the "oscules," as seen under the microscope

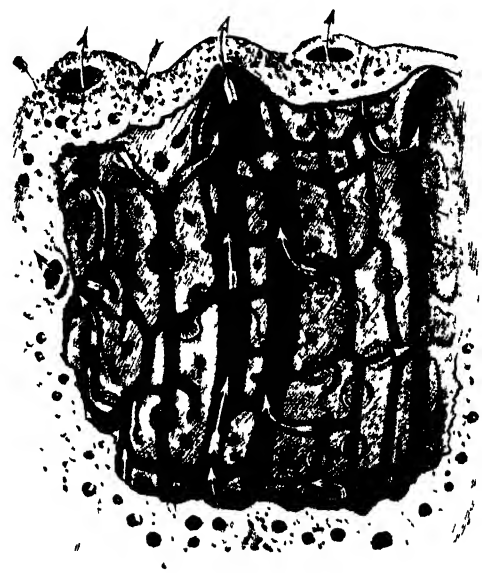
on cold mornings. In life it is the big seed-bearing fruit of the plant. When we are wise we avoid the big loofas, from which there may float out into our tub black, horrid-looking seeds, suggestive of cock-roaches given madly to natation. The smaller ones have been caught young and have no seeds. When they come to us the fleshy pulp has dried up and withered away, and just the skeletal fibres remain.

In spite of its gentle smoothness, the big, soft sponge is another whited sepulchre. If it administer a scratch or two, it is hardly surprising, since it is partly filled with bones. Our sponges are dead animals. Aristotle said so, two-and-twenty centuries ago, and for two thousand years posterity contradicted him—wrongly, as it proves. It is only one of hundreds of known species of such animals: mysterious creatures of diversified form, and pattern, and colour, and structure, and habit; soft, caressing sponges; sharp, brittle, glassy sponges, snapping at the lightest touch; sponges whose vast calcareous structures form the huge and strangely beautiful wonders for which the boggled imagination of early mariners could find no name but the Cup of Neptune.

There are sponges in every sea, in almost every river. There are sponges that tunnel through the adamant shell of the oyster to feast upon his vitals; there are sponges which slowly, little by little, eat their way into our cliffs and bring sections of the white walls of Old England tumbling about our affrighted ears.

If your sponge gives you a scratch in the bath you are reminded that beneath his soft and gentle exterior there once lurked spines and spicules, sharp as needles, exquisitely fashioned as the facets of the crystal. These are supports for his outer, softer parts, and for the vital network of canals and organs within, and a protection, too, from predaceous animals. The rose must have her thorn, the sponge his penetrating spicule.

All that honeycomb of tubes revealed to us in the bathroom sponge have had their part in the weal of the animal. The lesser ones are the canals by which food and oxygen are drawn in for assimilation; for the sponge both eats and drinks and



Diagrammatic Section of Sponge

The arrows show how the water enters by the small pores, to pass out by the large "oscules." Food is thus brought to the cells which line the channels

breathes. The food particles are caught at the junction of the canals in a delicate membrane, or filmy screen; the oxygen is extracted from the water, and exhausted fluid and debris are pumped out by way of the osculum—the large orifice which we discover upon the surface. Lowly as is his status in the animal scale, the sponge not is hatched from the egg within the parental canal; then out with a gulp of ejected water it goes, by way of the osculum, into the waste ways of the vasty deep. The family sponge is safely anchored at the bottom of the sea. Young Hopeful is off with his "Come I may, but go I must." And while the old folks at home are con-

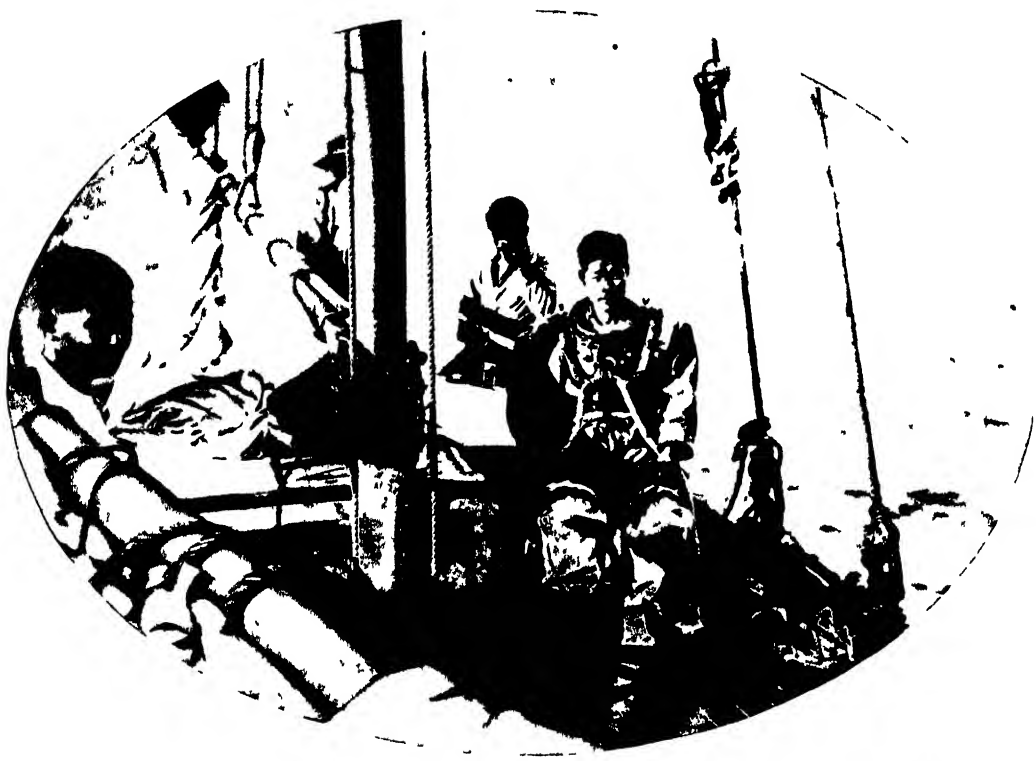
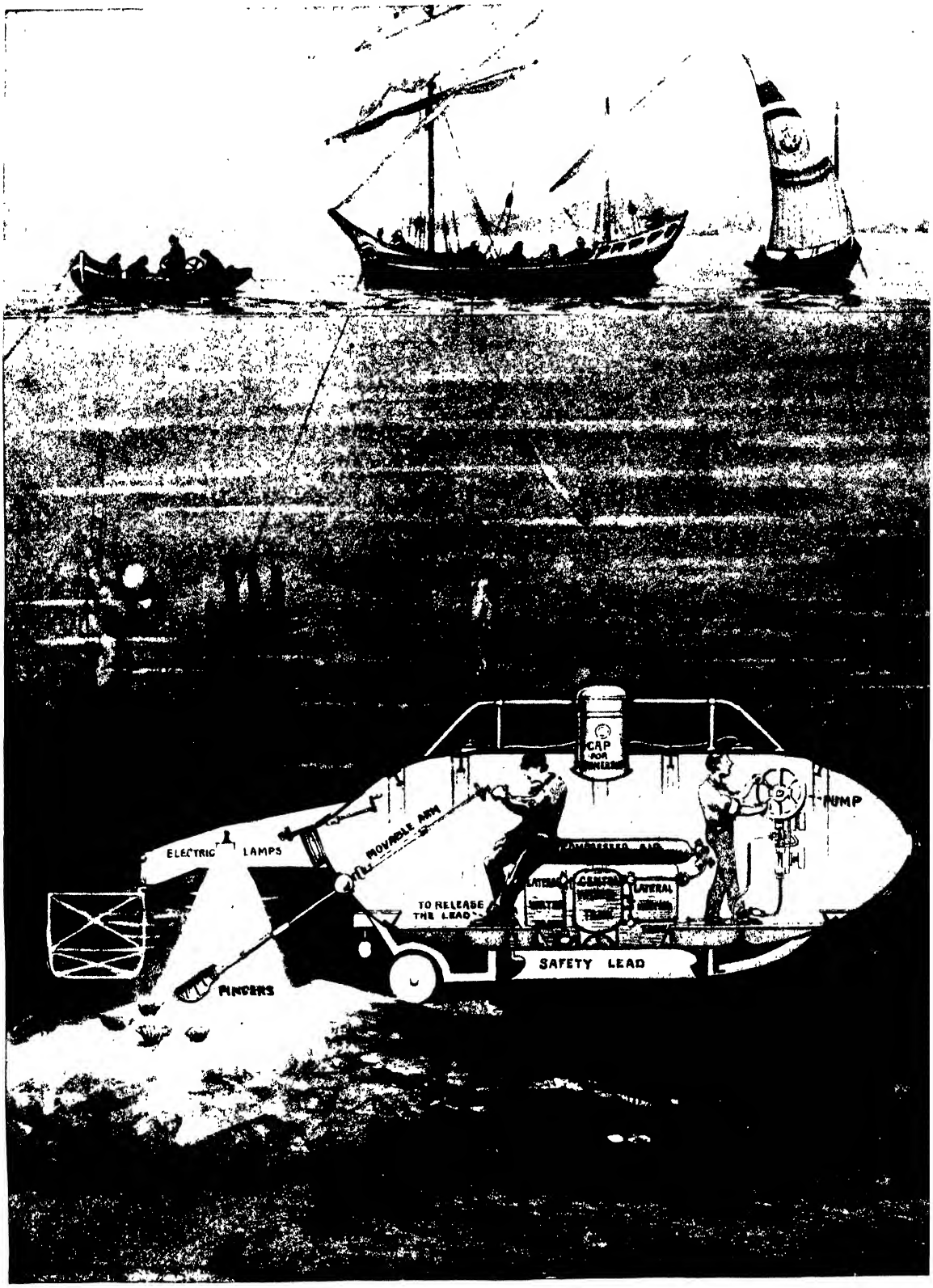


Photo Lafayette Studio, Perth H A

Explorers of the Deep, the Home of Pearls and Sponges

only boasts an organism of considerable complexity, but is decidedly a man of feeling. In his quest for sustenance—or is it when he yawns?—he protrudes the gelatinous membrane lining the osculum, and if that be touched by the needle of the naturalist, he shrinks indignantly and pained within himself.

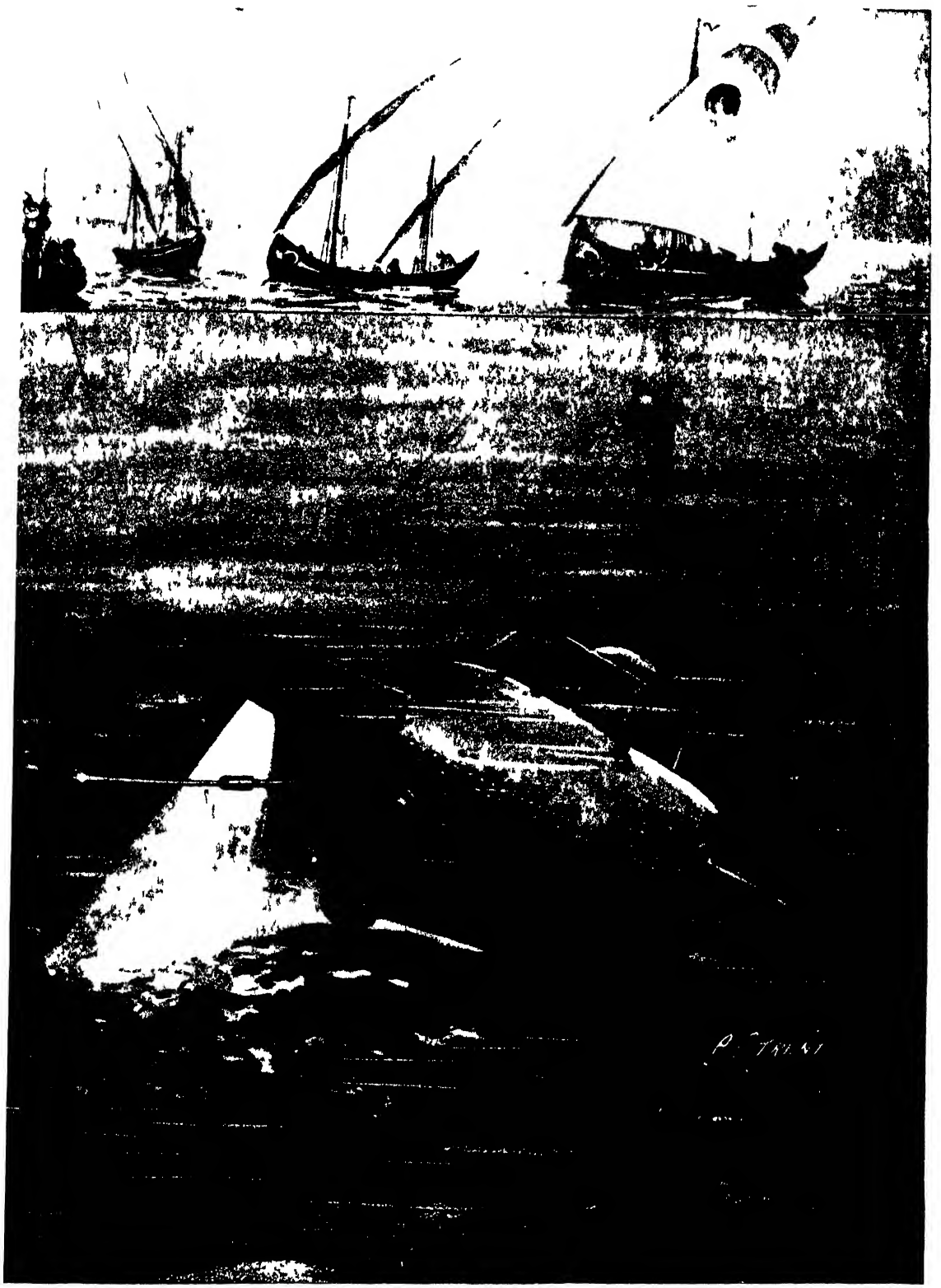
A junior sponge may come into the world at once child and parent. Inside its delicate frame, when it emerges from the ovum, there may be already within it the next generation of that old patrician house of Turkish bath-sponge. The infant sponge tent gently to sway at anchor in a tide fat with food, he plunges away like a microscopic porpoise, and begins to grow a beard—a beard of minute hair-like processes called cilia, which whirl like tiny flails, and propel him through the water with such vigour that, should he pause an instant for reflection, he is twiddled round and round like a little marine humming-top. But that sort of thing could not go on for ever. He acquires an introspective mood, begins to look within, as it were, and disappears down his own throat! That is to say, half of him does. The bearded lower half of the



A WONDERFUL MECHANICAL DIVER USED FO

(Drawn by A. C. Trent, from a Pict

It is believed that the ingenious contrivance here illustrated may eventually do away with the old method of spong seven feet in diameter, and carries two men. It has no engines, and is propelled by oars. It is raised and su the raising apparatus refuses to work, and will so ligh



ICKING SPONGES FROM THE SEA BOTTOM OFF TUNIS

urteously lent by John Phi lips and Sons)

thering The Abbé Raoul, Vicar-General of Carthage, is the inventor. The vessel is nearly seventeen feet long and
' means of water-tanks, while at the bottom of the boat is fixed a weighty safety-lead, which can be released if
e vessel that it will rise to the surface of its own accord

body curves in, and where before you had an oval, now you have the rudiments of a tiny cup-shaped sponge. All the internal mechanism undergoes a rapid change. Cells grow into canals and other like marvels of spongy development. At present he is a small pulsating mass of substance, resembling that from which Nature first evolved horn and hair; but the essential life-part of the little beast takes up residence upon the lip of the cup, as it were.

The ambition of the gay rover becomes

One of the Largest Sponges Ever Found

slowly chilled. Our tear-away voyageur begins to experience that tired feeling which is not peculiar to sponges, and he wants to sit down. It may be that he or she—or both in one, for sponges are, as a rule, bi-sexual—settles down alone or in company. Generally it is in company, as in the best-known case of the Bread-crumb sponge, where a hundred little canals ensnare prey for half a score of tiny appetites; and the latter number of very little sponges become one colony of tolerable-sized sponges. That, at least, was the theory until but the other day, since when it has come to be suspected, from the latest investigations upon the point, that where these colonies are formed the individual entities of the assemblage are not preserved. It is believed that, as in the case of some of the *Echinoderma* (in which are included sea-lilies, starfishes, and sea-urchins), where two baby forms meet and literally grow into one animal, so where several sponges meet, they cleave together and become one flesh; that, thereafter, the multiplicity of mouths and canals that we see represent, not a number of distinct individuals, but the duplication of parts necessary for the maintenance of a number of little animals which have grown together, as the bud and the tree upon which it is grafted grow together.

These are some of the adventures which enliven the career of the bath sponge before he becomes an involuntary participant in our morning ablutions. Between his setting up house for himself and becoming an intimate part of ours, there is quite a tragic interlude. Men descend into the depths and wrench him from his anchorage, by hand, or with spears with grapnel hooks. Some cannot be got at in this way, for they have been grappled by chance nearly twenty thousand feet down in the North Pacific. The best come from the Eastern Mediterranean; the second best—the big, but coarser—are ravaged from the deeps of Florida and the West Indies. When first brought up the sponges are filled with fleshy, glutinous matter, which has to be cleared away by drying in the sun. Various processes for the purification of the animal follow, before he is finally put into bales and packed off to market. The part that finally accompanies us into the bath is simply the skeleton; all the rest disappears in the process of cleansing; but until exposed to the air the sponge is alive, and wise fishermen, if they do not immediately need the sacrifice of his life, keep him alive and feeding in protected sea waters, where he continues growing to order.

The Riddle of Immunity

Innocuous Poisons—Man's Wonderful Constitution

By HOWARD TRIPP, M.A., Ph.D., F.C.S.

MANY people of nervous disposition would be frightened if they were told that they were in the daily habit of consuming a virulent poison contained in the homely and harmless potato; or if informed that the characteristic flavour of bitter almonds is due to the presence of the highly poisonous prussic acid. Yet such indeed is the case. The potato fruit and leaves contain a substance called "solanine," a lustrous crystalline solid, which, though white and innocent looking, is yet a deadly poison. Two grains of it given to a rabbit produce paralysis of the posterior extremities, and death within two hours. But the proportion of solanine in the potato is so exceedingly small that its effect is negligible.

Photo Underwood and Underwood

An Austrian Peasant Woman (of Istria)

Medical literature, however, affords a much more startling instance of the consumption of poison without ill effects. It has long been known that, in countries where arsenic is found as a mineral, the inhabitants are wont to mix it with the food given to horses to improve their coat and to increase their agility. In the north and north-west of Styria, in Austria, districts famous for minerals and for the ibex, many of the peasants are habitual takers of this dread substance, either in the form of the yellowish mineral "orpiment," or as "white arsenic," the common form of the drug. Orpiment, or yellow sulphide of arsenic, is used in the arts and manufactures, as for example in the printing of indigo colours. A mixture of it with lime and water has been used for centuries in Turkey for removing hair from the face, a kind of "dry shave"; and it is also employed as a constituent of sheep dips.

White arsenic has a weak sweetish taste, and is used in making arsenical preparations for medicinal uses, in the manufacture of pigments and of glass, for impregnating fly-papers, and as a preservative in the stuffing of zoological specimens. A dose of 1 grain is very dangerous, and one of from 2 to 4 grains is almost always fatal. It is so deadly that vendors have to sell it mixed

with some other coloured substance, as, for example, soot, as it has been sold so often in mistake for flour.

The Arsenic Eaters

The Styrian arsenic eaters are virile folk, who mostly lead an out-of-door life. Woodcutters, foresters, grooms, and smugglers are, in particular, addicted to the habit. They begin by taking a small piece about the size of a grain of millet, when the moon is in its first quarter, gradually increasing the dose until, at full moon, they sometimes swallow pieces as large as a pea. When the moon begins to wane the daily dose is gradually reduced until at the time of new moon none is taken at all. During the period of indulgence many refuse to eat the arsenic directly after drinking, and others abstain from it when they partake of fatty food. When asked why they practise the habit, they reply that it makes them healthy and strong, increases their weight, and improves their complexion. Directly the dose is taken, they experience a warm, comfortable feeling in the stomach, and only if they take too much do they feel a certain dizziness in the head. Otherwise there are apparently no ill effects whatever, and this marvellous fact, which has been investigated and proved to the satisfaction of the scientific world, has long been, and is still, without any adequate explanation.

The practice is continued as a rule for twenty or thirty years. Many begin it in their eighteenth year, and some have lived to a very old age. On the other hand, should the dose be reduced too suddenly, or should it be given up entirely for a time, the body is reduced to a state of weakness, and the craving for it compels them to indulge again. Generally these uncanny men keep their habit a secret, but this fact has not prevented the medical profession from thoroughly investigating the phenomenon.

At the Congress of Physicians and Scientists held at Gray in 1875, two arsenic eaters were exhibited and given fatal doses of arsenic. A subsequent medical examination proved them to be absolutely fit and well. Corroborative evidence of a like character is plentiful.

Analogous cases to that above described are the gradual adaptation of the body to morphia and nicotine. On the horrors of the morphia habit this is not the place to dwell, but a few words upon the character of nicotine, the active principle of tobacco, will not be out of place. After extraction from tobacco, nicotine is seen as a colourless liquid, which goes brown on exposure to light; it is slightly heavier than water, and has a sharp burning taste, and a tendency to go off as a vapour. The amount of it in cut tobacco varies considerably, but it is never great, varying from 0·5 to 5 per cent. of the dried leaf. When the fragrant weed is smoked, much of the nicotine either goes off as vapour or is changed by heat into other products, but some of it is absorbed into the system. The effect of this absorption varies with the individual. The majority of medical men would undoubtedly admit that the average healthy man in no way suffers from a moderate indulgence, and may benefit from it owing to its soothing action on the nervous system.

Sir Walter Raleigh

It is recorded that Sir Walter Raleigh "tooke a pipe of tobacco a little before he went to the scaffolde, which some female persons were scandalised at." Further, experiments have conclusively shown that tobacco smoke is fatal to many disease germs. As long ago as 1665, during the Great Plague of London, it was remarked that the doctors who attended the sick, and the men who carted away the dead, smoked incessantly, and so remained remarkably immune from the pest. On the other hand there can be no doubt as to the baneful effects which follow over-indulgence.

Arsenic and nicotine are both fatal to man, yet such is the wonderful nature of his constitution that he is able to accustom himself to relatively large quantities of them without any apparent harm.

The Rorqual Whale whose Ancestors had Legs

Miracles of Evolution

How Whales once Walked and Snakes Ran—Fingerposts to the Past

By N. F. WATSON

THOUGH there be freakish examples of fish which charge their gills with moisture and veritably march dry-finned overland, no member of the group can exist upon atmospheric oxygen; the whale must, and does. It must rise to the surface to breathe—it is not, therefore, a fish. It is, indeed, a limbless, warm-blooded mammal, nourishing its young upon the milk of cetacean kindness in manner like unto the patient cow. And once Leviathan thundered with elephantine tread upon the land that knew not man.

Even now it is not accurate to term him "limbless." The flippers or paddles, now modified into fin-like hands, are vestiges of the colossal forelegs and feet that once sustained his mighty bulk. He is five-fingered (or five-toed) or four-fingered, according to his order. The sperm, or toothed, whale has the same number of fingers to his hands as man; the whalebone whale has sacrificed a finger from either hand. To discover the hind limbs, we have to probe deeper than the average anatomist cares to delve. But, hidden in the lower part of the whale's body are the surprising remnants of what were the hind limbs, true organs of locomotion. There remain to-day but the slowly-vanishing relics of pelvic girdle, thigh-bone, and one of the lower bones of the leg. These suffice, however, to reveal a chapter of evolutionary history of that misty, terrific epoch in

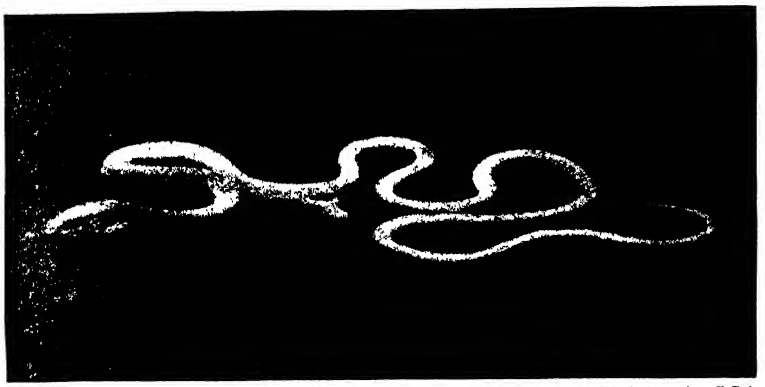


Photo: W. S. Berridge, F.Z.S.

Scale-foot Lizard (*Pygopus lepidopodus*)

hind extremities beneath him, can bowl along over quite rough ground at a lumbering canter, the seal has his hind legs flattened out immovably, webbed together horizontally at the tail, so as to make them an encumbrance rather than an aid to land travel.

Sea animals are not

Photo: W. S. Berridge,

Section of an Indian Python, showing Spurs (vestiges of Hind Limbs)

which whales were among the giants under whose perambulations the earth trembled.

The fin-footed carnivores—seals and sea-lions—are descended from true land animals, and themselves come ashore for three or four months at a time, for each nursery season. The seal has become more specialised—or degenerate—than the sea-lion, for whereas the latter, doubling his flipper-like

Photo: E. Step, F.L.S.

Slow-Worm (*Anguis fragilis*)

peculiar in this sacrifice of limbs to changing conditions. The reptile world teems

with examples. Snakes were all four-footed animals once upon a day. Developing on elongated, cylindrical lines, habituating themselves to burrowing, to tree-climbing and swimming, they found limbs of diminishing utility, and gradually discarded them.

To-day a snake propels itself by gripping the ground by means of strong adjustable abdominal scales or plates. Each scale corresponds to a pair of ribs, and as an inequality is gripped by the scales, each pair of ribs imparts a forward pull, the entire body advancing by a series of horizontal wriggles. But for all their long disuse, the limbs of the serpent remain as vestiges. Even in the greatest of the snakes, the boas and pythons, we find small but strong external claw-like processes to remind us of the legs that once the serpent used, and within the interior are the last of the bones that once enabled the reptile to walk.

A Gorged Python

Even in the greatest of the snakes we find small but strong external claw-like processes to remind us of the legs that once the serpent used

The peculiarity extends moreover, to the salamanders and lizards. In some only a pair of legs has been sacrificed, two still remaining. In others, however, such as that much misused lizard, the slow-worm, the four have entirely disappeared. The slow-worm, or blind-worm, so-called, is almost universally treated as a snake. But although it is undoubtedly snake-like in outline, it is no more snake than worm, and as little blind as either, as its quite pretty little eyes proclaim. Unlike the snake, it has eyelids, external evidence of ears, and cannot withdraw its tongue into a sheath. But in common with the snake, it is absolutely limbless, though it is in internal structure and in habits a bona-fide lizard, and, like many others of its class, will, on summarily taking French leave of you, permit you to retain its tail, while the rest of the amiable little reptile wriggles on its way rejoicing. There are four of these insect-eating lizards within

six feet of the chair in which this note is written, without a tail-piece among them. They have voluntarily shed those appendages; but evolution and adaptation to habitat are responsible for the absence of their feet and legs.

Even the amphibia—vertebrates born in water, in which they pass through various larval stages, and come ashore when mature—have developed this habit of becoming limbless. The Cæcilians have assumed a true wormlike form, and not a vestige remains of the four legs and feet which they formerly shared in common with the newts and salamanders, of which they are the degenerate collateral descendants. It all seems strange and bizarre and incomprehensible, of course, but that a whale should surrender the legs no longer serviceable to a deep-sea lord, or a snake discard the feet which would impede its writhing progress up a tree is, after all, not more startling than that a bird should yield up the paramount gift of aerial flight, or that a butterfly, resplendent as the rainbow, should pass its days in the sunlit world fasting, incapable of sipping so much as one drop of nectar from the floral goblets among which it flits. Many puzzling problems of this character confront the student of Nature.

A Summary of the Natural History of Millions of Years

In the story of the bull-frog (here shown) and his brethren is retold the origin and rise of all terrestrial life

If you would see a summary of the natural history of millions upon millions of years unfolded before your eyes, consider the humble frog and his order. The story of the origin and rise of all terrestrial life is retold in the brief but startling chapters in which the career and adventures of this lowly group of animals are written. Here are the lowest rungs of the ladder by

which life climbed out of the waters to possess the earth.

The frogs, newts, and salamanders are generally regarded as reptiles. As a fact, they are not nearly so highly organised as their scaly kindred. They form the order, already mentioned, called amphibia. We wrongly term the hippopotamus an amphibian, because it divides its time between water and land. But the scientist means by an amphibian an animal which is born in the water, which during its larval stage breathes water, which, upon the completion of its metamorphosis, discards its water-breathing gills, takes unto itself lungs, and breathes atmospheric air. The true amphibian would drown in air, during its larval stage; it would ultimately drown in water after assuming the perfect shape. Once all animal life dwelt in the waters, and, as no amphibian known to the naturalist can to-day tolerate the least saltness in its watery element, we may assume that in those days the seas had not become brackish. In the water dwelt the life of the world, and the amphibia were the animals that led the way out. Certain forms became the pioneers to hazard the great adventure of a trip ashore, or, cast up by one tide, they would be left to shift for themselves, high and dry upon a waterless beach, until the following

Photo H. S. Berridge, F.Z.S.

The Gill-breathing Axolotl

This gill-breathing tadpole is capable alternately of turning into a lung-breathing Amblystoma, or of remaining a tadpole and breeding in that state

Photo H. S. Berridge, F.Z.S.

From Axolotl to Amblystoma

This picture shows the creature at an intermediate stage in its transformation. The head is much flattened and the branching gill-covers reduced to mere knobs

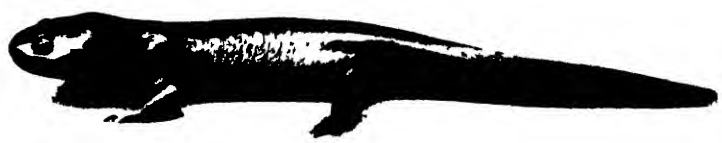


Photo H. S. Berridge, F.Z.S.

The Transformed Lung-breathing Amblystoma

The final stage in the transformation of the wonderful Axolotl. If food is abundant it does not trouble to change from its tadpole stage

tide came to sweep them back. Through millions of years certain forms of animals which had developed backbones gradually habituated themselves to taking in, in increasing quantities, gulps of air in place of oxygen extracted from the water, and slowly, very gradually, lungs were evolved to render them independent of the river, the lake or the sea. The process of emancipation is recapitulated in the history of every frog and toad, newt and salamander born to-day into this world of ours. From these primeval amphibians developed reptiles, from reptiles came birds, and from the ancestors of reptiles developed mammals, of which the head is man himself. Man, mouse and monkey were all at one time cousins to the ancestors of salamander and frog.

Think of the miracle that the life of the modern frog represents! When it quits the globular egg in which it has undergone the first stage of development, the tadpole issues practically a fish. It has a round, lamprey-like sucker-mouth; no limbs, no fins. It swims by means of the tail. For the first few days it lives, as the salmon lives, upon the unexhausted residue of yolk in the egg-sac; and it devours the capsule whence it has escaped, after the fashion of the newly-hatched caterpillar. It has primitive gills, as every fish has, and as man once had. It breathes by means of these gills, breathes water, and drowns in the open if you remove it from the water. In the course of the next few weeks—the temperature of the water and the nature of the food supply largely determining progress—its little hind legs bud forth; the external gills disappear, to be replaced by internal gills. Then the horny jaws of the sucker-mouth are cast, and the true head and mouth of the frog appear. Through the aperture formed by the first gills the little arms are thrust, and lo, a "fish" has become a land animal, which must now come ashore or die—drowned in the water as you or I would drown.

The Modern Frog

As the caterpillar and the lobster cannot eat when they are undergoing one of their moults of skin or shell, so the little frog must fast when changing his shape from fish to flesh. He lives upon his tail. Once his sucker-mouth is gone, he has no means of eating in the water. His food must now be caught by means of his sticky telescopic tongue, which is useless, of course, in water. So he absorbs his tail, which diminishes as the hump of a camel diminishes during a hard march through unwatered desert. He is practically tailless when he leaps to the land, a ravenous, carnivorous little animal. And what now do we find? Had he remained a fish, he would have developed fins. But instead of fins he has hands and feet, fingers and toes. Our hands and feet are only modifications of his hands and feet. Watch a common garden frog eating a worm, and you will see him use his hands to adjust the wriggling morsel in his mouth the more easily to swallow it. The smooth, spur-toed frog employs his hands to catch prey in the water, and having no use for tongue, has discarded it, as have the Surinam toad and one or two others.

From forms such as the amphibian all terrestrial forms have arisen. The mighty Labyrinthodont was an amphibian; so was the Giant Salamander, whose remains, unearthed from time to time, are invariably announced to the world as those of a fossil man. The great march of life has streamed past the amphibians and left these milestones to mark the way by which it has gone. What links do we find between these living relics and present-day life-forms of the higher orders? The head of the amphibian is articulated to the spinal column in exactly the same way as in the exalted mammal. This is not the case with birds or reptiles. Certain toads have developed a poison which is similar in properties and effects to that of serpent virus. Only warm-blooded mammals are

Mighty Amphibia

Six Typical Amphibians

1. White's Tree Frog (*Hyla cœrulea*)
2. Noisy Frog (*Rana clamata*)
3. Hellbender (*Menopoma alleghaniensis*)
4. Congo Snake (*Amphiuma me*
5. Tadpole (of *Xenopu* *laev*)
6. Brazilian Frog (*Ceratophry*)

supposed to have hair, but one frog, the *Trichobatrachus robustus*, of West Africa, has a hairy covering! Unlike fishes and the majority of reptiles, many amphibia reveal the most extraordinary solicitude for their young, and so approximate to mammalian intelligence. The flying-frogs have had to learn the art of aerial travel in order that they may safely ascend trees in which to deposit their spawn. Some capsule them by an extraordinary growth of skin, from which, in due course, emerge, not tadpoles, but true frogs. Another species, the *Nototrema*, carry the eggs in a sort of marsupial pouch, in which the marsupium of the kangaroo, the opossum, and other primitive mammals might seem to be foreshadowed. Thus these nursery habits foretell the cradles of the paradise fish, the cuckoo-spit, and the kangaroo.

Photo W. S. Berridge, F.Z.S.

A Golden Tree Frog

of the tree frogs unite two broad leaves to form a nest, and in this secrete a frothy mass in which the eggs are deposited. Others, tree frogs again (*Hyla faber*), emulate the beaver, and construct in the water as fine a dam for their little ones' cradle as ever the famous fur-bearer made. Then we have the marvellous care of such creatures as the obstetric frog, the male of which carries the eggs wound about his legs, until they hatch; of the female of the *Hyla goeldii* and the Surinam toad, which, assisted by the assiduous male, place the eggs upon their backs and en-

Among the salamanders we find many links with higher life. There is the Alpine salamander, for example, which produces, not eggs, but live young; the Autodax, which deposits its eggs in holes in trees thirty feet from the ground, and defends them with the ferocity of a tigress. Most wonderful of all we have the Axolotl, which is really the tadpole stage of the Amblystoma, an amphibian which occasionally forgets the call of Nature to "March!" If fresh water and food are abundant, it halts where Nature once left it, æons ago, and breeds in the larval condition.

Entering the Pipe Leading to a Compressed-Air Chamber

The illustration shows French workmen on their way to work in a tube that passes beneath a river. The pipe gives access to a compressed-air chamber. The air pressure is gradually increased or decreased in order to avoid the injury to the system caused by sudden change in pressure and density

The Railways of the Netherworld

The "Tubes"—How They Have Solved the Traffic Problem in Great Cities

By W. HUTTON WILLIAMS, A.R.S.M., M.I.M.M.

OF all the problems which have confronted the engineer during the past twenty years, none has been more persistent than that of the relief of traffic congestion in our great cities.

Surface Congestion

City after city has discovered, when the cost of acquiring property at surface has become prohibitive, that its main traffic arteries are hopelessly faulty in design for efficient service; and the false expedients which have been devised for relief, only to present new and more difficult problems, are too familiar to need enumeration.

There are three types of congestion—pedestrian, passenger vehicular, and freight vehicular, the last two being capable of further subdivision.

In many cities the congestion on the footpath itself is so great that walking is a waste of time. In parts of the City of London an hour's hard walk at noon would accomplish less than a mile and a half.

Each large city presents a different problem for solution, as the result of the conditions which have governed its growth. London's chief problem has been to secure a passenger transport service connecting the districts, constantly expanding north, south, and west, with the City business centre and the busy port to the East.

In Paris the problem was partly a military one. It was necessary to secure intercommunication between isolated suburbs set radially about the centre, both within and without the fortifications, as well as to make possible the rapid concentration of troops at any part of the defences.

In Chicago, following on the extension of the railway system of America, it became imperative to find some means of handling the freight transfers of the twenty-five great trunk lines which meet there.

New York City has had to face the most difficult problems of all. Here the original city, situated on the long and narrow Manhattan Island, has extended south-east over the southern portion of Long Island (owing to port facilities) and west, on to the mainland around the termini of the trunk lines which serve the continent. The problem in New York was that of establishing intercommunication north and south along the axis of Manhattan Island, and east and west across the broad East River to Brooklyn, and the great estuary of the Hudson to Jersey City on the mainland.

Discontinuity of surface has been one of the many factors indicating subterranean communications. It was the necessity for communication between the north and south banks of the Thames, below the lowest existing bridges, which led to the construction of the first works of the kind in our city of London.

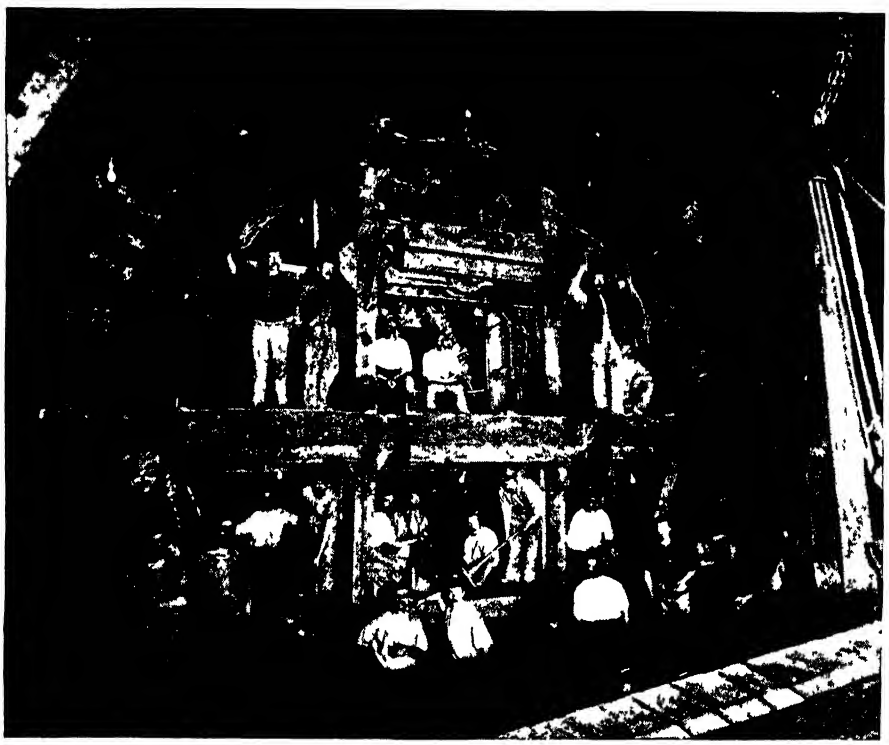
Elevated Railways

The first attempts to relieve congestion of traffic at surface took the form of elevated railways, and those of New York and several continental cities are models of ingenuity in construction. These, however, except in those cases such as the Barmen-Elberfeld Monorail, where they can be constructed over existing water courses, invariably introduce other undesirable conditions.

II.—In the Underworld Railways of Netherworld Artificial

The early subterranean railways (such as the London Metropolitan and District) were constructed on the cut-and-cover system. Steam was the motive power used by the trains, and the use of fire under the boiler, with the attendant smoke difficulty, made large tunnel sections and frequent communication with the open air imperative.

The conditions which have led immediately to the construction of relatively deep tunnel communications have been accurate geological knowledge of the continuity and thickness of certain soft strata, and the march of physical science in the department of electricity, combined with the ingenuity of the engineer in following closely the discovery of scientists in both domains, and bending them to service in his work of construction.



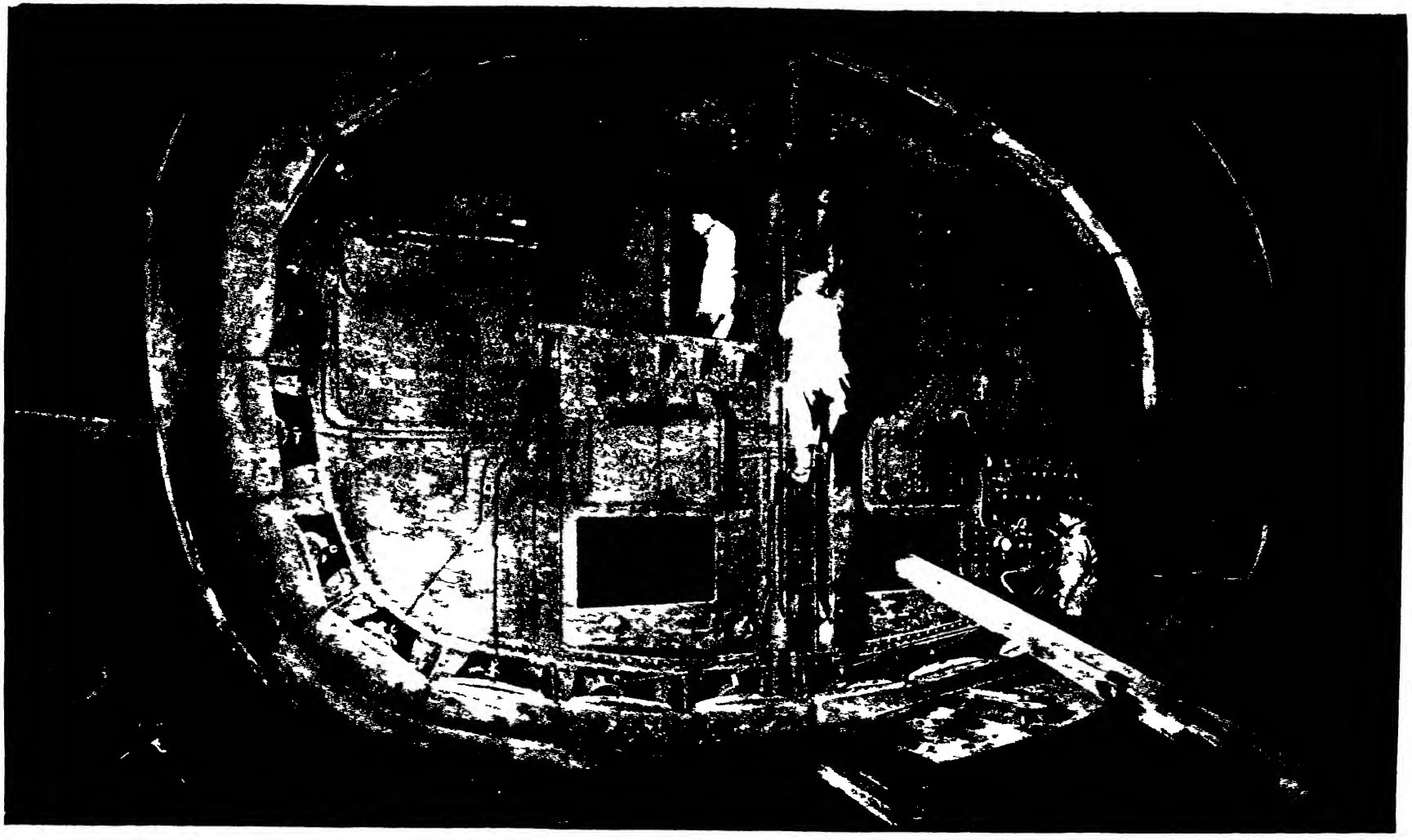
The Front of a "Shield"

The illustration shows a station tunnel, 21 feet in diameter

It must not be imagined that all cities can be provided with such an admirable system of deep-level underground communications as London has. Had it not been for the existence of the stratum known as the London clay, which overlies the chalk and lower London tertiaries, the construction of such communications, if they existed at all, would have been on the cut-and-cover system, to take advantage of the soft subsoil. Economic considerations would have made them far more limited in extent, and we should also have felt great inconvenience in the way of traffic dislocation during their construction, instead of waking up one morning to find the wonder of a new tube (dry, well-ventilated and lighted, and in full operation) ready to convey us in comfort to our daily avocation.

In the Paris Metropolitan and the New York subway, we find typical cut-and-cover work, and the London County Council tramway tunnel under Kingsway is an excellent example of the type of such construction. The necessary arrangements for traffic diversion, and acquirement of surface property, add enormously to the cost of an undertaking of this kind.

Both Paris and New York present the same difficulty of rock at or near the surface with a certain thickness of subsoil and surface gravels to help out. A large

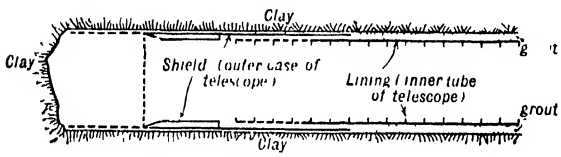


How Man Copies the Methods of the Humble Earthworm

The methods which have been used by engineers under the term ' shield tunnelling ' are closely analogous to those works carried out by the humble earthworm. The shield is a hollow, cylindrical body, which cuts its way steadily through the soft stratum in which it is used, the excavated materials passing thro gh its nter or The movement forward is caused by setting in motion a number of hydraulic jacks

proportion of the New York subway had to be blasted from the solid rock. New York has the added complication of the necessity of carrying the tunnels beneath wide and deep river channels.

London and Chicago are related, in that each is underlain by a thick substratum of plastic clay and an admirable medium in which to construct deep underground communication; but the problem in the one case has been the transport of passengers, and in the other that of freight. The latter city possesses some sixty or seventy miles of underground railway on which not a single passenger is carried, the work of transport being confined to mails, merchandise, coal, and rubbish. The track serves every street in the business district, and a great deal of the residential quarter. Goods for delivery to the railway termini



How the Shield Works

or other parts of the city are sent to the nearest collecting station and conveyed over the railway system. Ashes and coal are collected and distributed in the same way. The mail bags are handled on mechanical elevators, from the subway into the post-office building and vice versa, and the streets are relieved of freight traffic to the extent of about 30,000 tons daily. Large business houses have private lift shafts from the basements to the subway below. In recent years, wherever a large building has been erected, a temporary shaft has been constructed to the subway, and all the excavated material from the foundations has been fed straight into cars below, at an average depth of 45 feet below the surface.

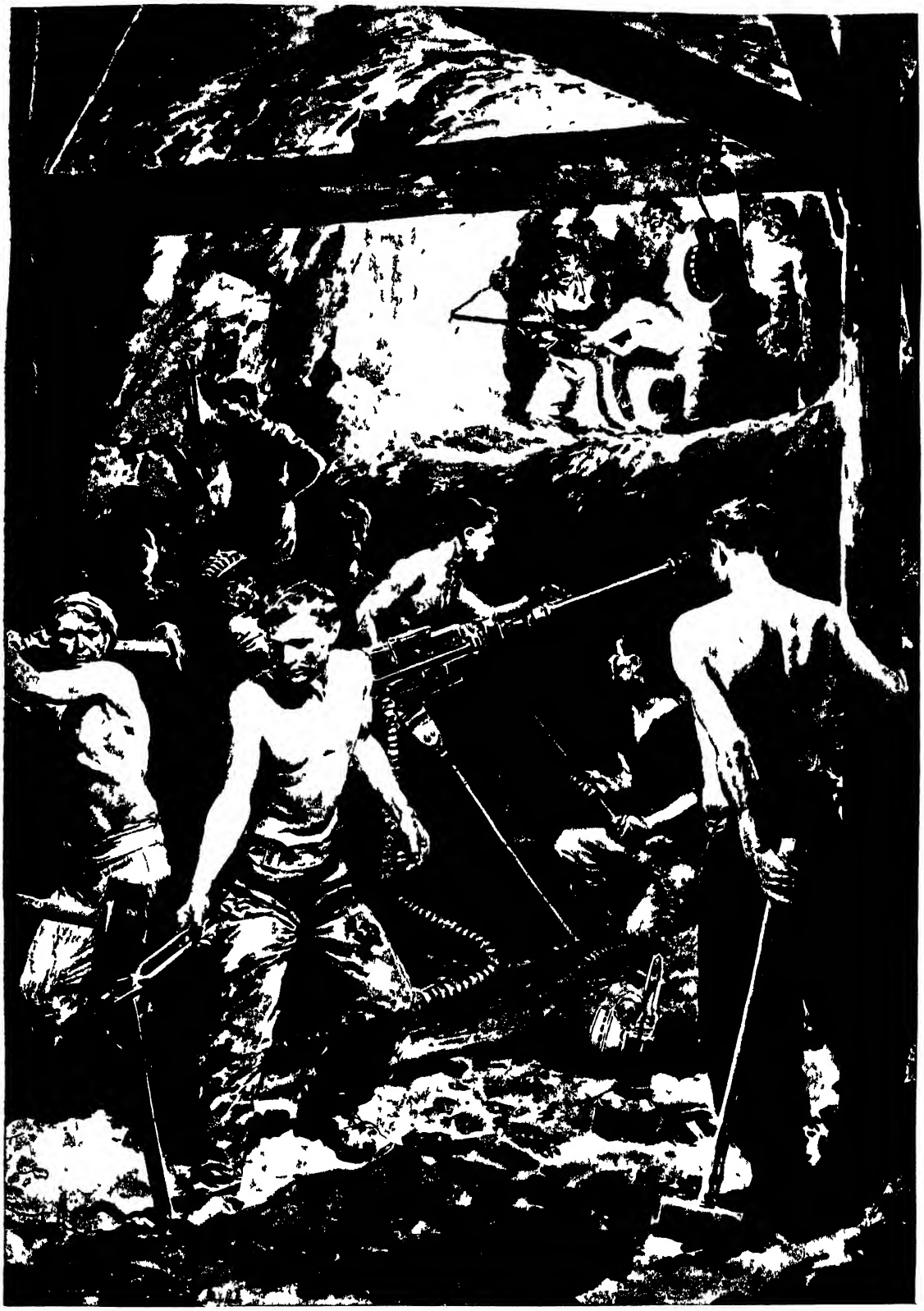
The tunnelling for Chicago's freight railway was carried out at the rate of some 300 feet per day, and the excavated material added a park of over twenty acres on the lake shore to the city's open spaces, free of cost to the community. The tunnelling was carried out with hand tools only and without a shield, just sufficient air pressure being used (about .8 lb. to the square inch over atmospheric) to keep the water from trickling into the tunnel at the working face. The concreting followed closely, shift by shift, behind the excavation.

The first engineer to use a shield for the protection of the workmen in tunnelling operations was Brunel, at the Thames Tunnel, completed in 1843; but the true tunnelling or Greathead shield was invented by J. H. Greathead, and used by him in the construction of the Tower Subway under the Thames, completed in 1869 and closed when the Tower Bridge was opened.

The successful execution in the eighties of a more ambitious tunnelling scheme with the same object in view—that of securing improved passenger traffic facilities between south and central London—combined with the strides made in electric traction, now opened up a new vista in the imagination of the engineer.

It is not generally known that it was originally intended to operate the King William Street and Elephant and Castle subway by a steel cable. Following on the successful construction and operation of this subway, it was for the first time generally realised that, conditions being similar under the whole of London, a network of subterranean railways was possible, to deal with the passenger traffic problem in every part of the city and suburbs. The year 1893 saw the construction authorised of no less than six separate tubes.

The methods which have been used by engineers under the term "shield tunnelling" are closely analogous to those works carried out by the humble earthworm. The shield is a hollow, cylindrical body, which cuts its way steadily through the soft stratum in which it is used, the excavated materials



Boring the Loetschberg Tunnel

(Drawn by I. Matania from Official Photographs)

This is a typical scene during the work of tunnelling through hard granite. One gang pushes forward an upper gallery, while another cuts it down to the desired depth. Simultaneously two other gangs are boring and blasting a tunnel to meet them.

passing through its interior. The Greathead shield consists of a short, hollow cylinder of steel about 7 feet to 10 feet in length with a diameter two inches greater than the proposed external diameter of the finished tube. This steel cylinder is capable of sliding forward, relatively to the tube cylinder, just as the parts of a telescope slide upon each other.

How the Shield Works

The movement forward is caused by setting in motion a number of hydraulic jacks. Shields have been used the rams of which are capable of pushing forward the shield with a total pressure of 5,000 tons.

During tunnelling in the London clay under normal conditions short timber struts, pointed at their ends, are placed completely round the forward end of the shield and are pressed forward into the clay by its movement. These serve to break up the clay and force it into a short length of tunnel about 5 feet by 5 feet, which is hand driven ahead of the shield and supported by temporary timbering.

The nearest timber supports of the tunnel having been removed, the controls are operated and pressure water admitted to the rams. The shield begins to move forward immediately. The short struts are pressed into the cheese-like substance of the clay, great lumps of which are forced to the centre. The shield having travelled forward a distance equal to the full length of the rams, about two inches more than the length of the segment rings, the rams are drawn back into their cylinders, leaving a space ready to receive the segments of the tube. These are next placed rapidly in position and bolted up. Small circular holes are bored in certain of the segments to receive the nozzle of the grouting machine, for forcing liquid concrete behind the segments to fill up the annular space between the outside of the tube and the clay. This grouting is carried out immediately after the bolting up of the segments of the new ring.

The speed of travel forward of the rams can be regulated with the greatest exactness, so that the shield can be successfully driven round curves, whether horizontal, vertical, or at an oblique angle.

Verticality is maintained by means of a plumb-bob suspended within it, and horizontal movement by means of measuring sticks set at each side.

One of the most important details of the engineer's work in connection with tube construction is surveying, and a heavy responsibility rests on the young engineers who are selected for this work. The construction of the later London tubes advanced so rapidly that continual watchfulness was necessary, and the young engineer leaving shift would have to show all in order, or put things straight before another would follow on. In the construction of the Central London, Hampstead, Piccadilly, and Brompton tubes, considerable lengths were driven by rotary diggers. A rotary cutting machine was fitted within the shield itself, and revolving cutters pared off the cheese-like clay as the shield advanced, a mechanical conveyer behind it passing the clay back to small trucks. The rate of advance over these sections, when the men had become expert at regulating the ram pressure was double that obtained from manual work.

Airlocks

When pressure has to be maintained to exclude water, an airlock must be set up in the tunnel. This usually consists of an old cylindrical boiler shell, built through an air-tight bulkhead, in the tube itself behind the shield. It is not moved forward, but remains in the same position for the whole length which is to be driven under compressed air. The airlock has two air-tight doors, one at each end of the cylindrical chamber. Both doors open in the direction in which the tunnel is advancing, and the pipe conveying compressed

air from the surface discharges in front of the airlock.

To pass through the airlock from without, the procedure is as follows: First telephone or signal for the farther door to be closed. Now open the valve which allows the compressed air to pass from the chamber to the air outside. The pressure in the chamber will then gradually decrease until it is equal to atmospheric pressure. You can now push open the outer door and pass in, closing the door after you, and also the valve previously opened; now open a second valve, which allows compressed air from the tunnel to enter the chamber until the air pressure in the chamber has been raised to that of the tunnel beyond. You can now open the farther door and pass through to the tunnel end.

The pressure required to exclude water when passing through a water-logged stratum is taken roughly at ½ lb. per square inch for each foot of head of water (the weight of a column of water, one inch in area and one foot in height, is 7 oz approximately). The necessary pressure must not be much exceeded, or there may be danger of a "blow-out." Working in compressed air, moreover, becomes dangerous at 30 lb. above atmospheric pressure.

There is always difficulty in excluding water from some part of a tunnel face, as the bottom of the face is several feet lower than the top, so that, for instance, in a twelve-foot tunnel the pressure required at the bottom would be 5½ lb. more, approximately, than that required at the top.

A blow-out takes place when the air-pressure at the tunnel end overcomes the pressure of the water and superincumbent soil, and the air is forced through the water-logged soil to the surface. In such a case the workmen must retire and rely on the safety diaphragm to save them from the inflow of water and sand, slime or gravel, which comes with it. Such a blow-out took place during the driving of the Waterloo and City tube beneath the Thames, and a very much more notable one during the driving of the Rapid Transit Subway extension through quicksand in the bed of the East River between Battery Point and Brooklyn. This blow-out was accompanied by a most extraordinary occurrence.

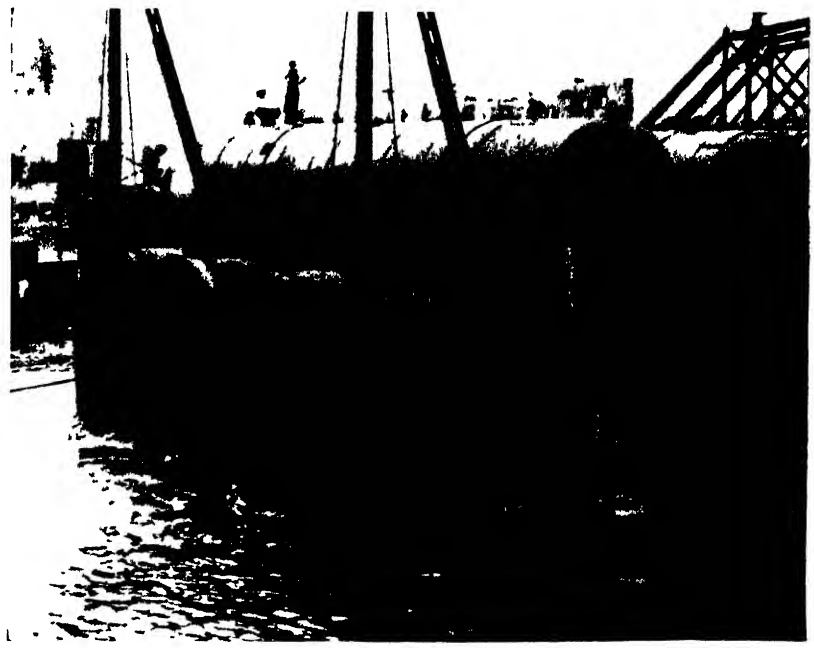
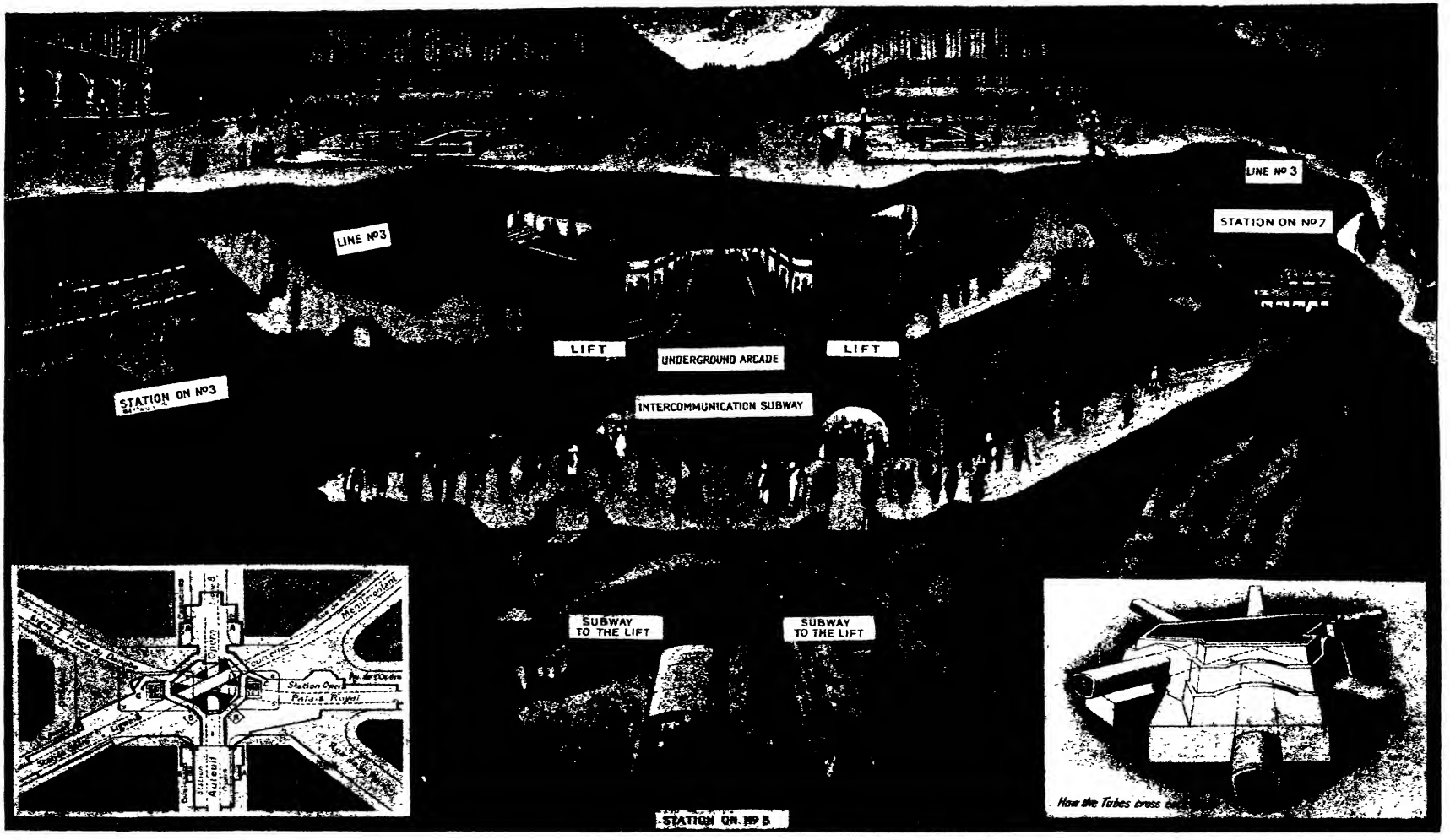


Photo Underwood and Underwood

Sinking a Tunnel instead of Digging it

Instead of tunnelling under the river for New York's Lexington Avenue subway, the four steel tubes to be used for the four tracks connecting Harlem with the Borough of the Bronx were sunk to the river bottom into a bed some 80 feet wide and 58 feet beneath mean tide level



How the Ground beneath a Giant City is Burrowed like an Ant Hill

(Drawn by Louis Trimpier)

The illustration shows what is taking place beneath the Place de l'Opera at Paris. Perhaps in time the dream of the imaginative novelist may be realised, and a great part of a city's population will not only travel but dwell in the netherworld

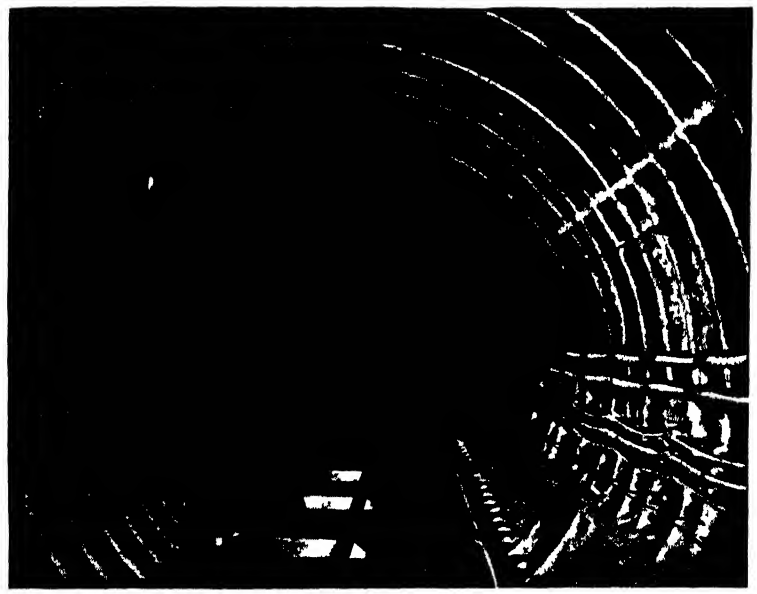
A workman at the tunnel face was ejected through the quicksand which forms the river-bed and the clay apron over it to the surface of the river above, whence he was rescued by a passing boat, very little the worse for his adventure!

A blow-out, like a small leak in a dyke, can always be prevented if tackled at once, but if neglected will produce disastrous results. When the hole begins a bundle of sacking or lump of clay stuffed into it will cure the trouble. If nothing else be handy, a man will push an arm or the body against the weak spot. In the case mentioned above such a precaution was taken, but the blow-out was so strong that it forced the man up with it.

The tunnels beneath the Hudson and East River at New York have presented some of the most interesting of shield tunnelling problems, and are monuments to the skill of the engineers.

The bed of the Hudson is, for the most part, river silt of the consistency of a stiff jelly, and considerable doubt existed as to whether it would offer adequate support for the weight of the completed tunnels. Experience showed, however, that there was no need for anxiety on this score. It was found that the closed shield could be forced through this material without any excavation, a lower door only of the safety diaphragm being left open to counteract a slight tendency to rise as it was thrust forward. Incredible speeds were attained when the whole shield had entered into this silt, 72 feet in one working day having been recorded. Many difficulties were, however, presented while the lower portion of the face was rock with silt above it, and it was found almost impossible to prevent flow along the rock face. Baking of the clay to harden it was one of the successful measures used. The lower Hudson tunnels are over a mile in length, with 5,000 feet in the silt.

The quicksands of the East River presented a more difficult problem still. In driving the Pennsylvania tunnels great steel caissons were first sunk down to the bed-rock on the banks and set in concrete.



A Finished Tube Tunnel (11½ feet diameter)

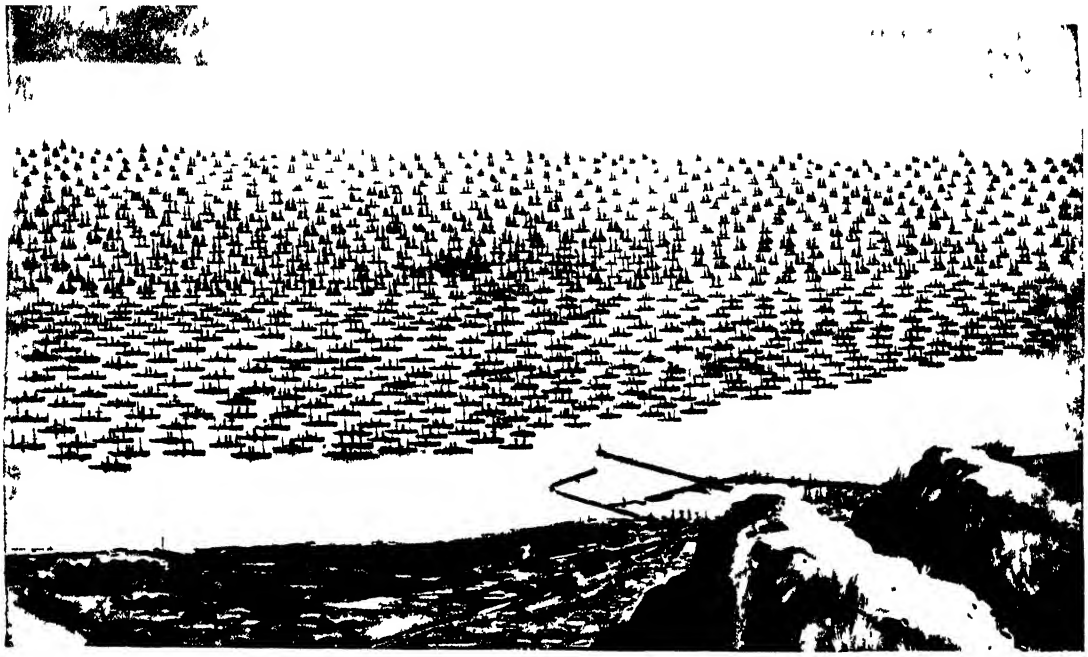
The shields were erected within these and driven forward. A continuous battle with quicksand followed. The thickness above the tunnel was often so small that quantities of clay had to be dumped on the river bottom to enable the necessary air pressure to be maintained.

Ingenious methods were used in the construction of the Lexington Avenue subway under the Harlem River. A bed for the four parallel tubes was dredged in the river bottom 58 feet below mean tide level, and the tubes, built at the surface, were floated over the site and lowered into the bed prepared for them, the sinking being controlled by air cylinders attached above them as shown in the illustration on page 591.

Unfolding a Collapsible Berthon Boat

(Drawn by N Sotheby Pitcher)

So long ago as 1850 a clergyman, the Rev. E L Berthon, busied himself with a project for a type of collapsible life-boat, capable of being stowed flat and opened out only when needed. To-day this type of



A Single Year's Toll of the Sea more than 1,000 Ships

Making Ocean Travel Safe

The Wonderful Devices by which the Floating Hotel is Shielded

By HORACE C. DAVIS

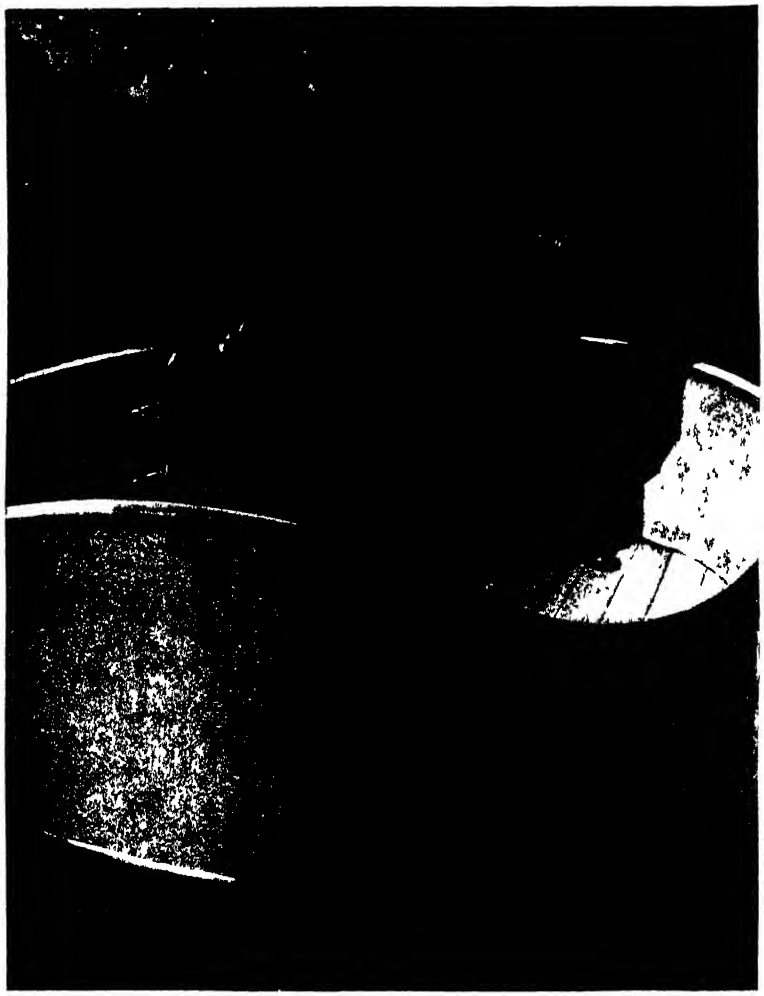
UNTIL the appalling disaster to the *Titanic* suddenly shocked the whole civilised world, the travelling public had come to look upon the gigantic liner as simply a floating hotel, quite as safe to sleep and spend a week or so in as a solid brick and stone structure ashore. Luxury after luxury had been added in each successive ship, from children's playrooms to well-appointed gymnasia and private suites with private promenade decks and growing flowers, and finally a large swimming bath.

People hardly noticed the rows of lifeboats, or openly complained that they only took up room on the popular upper deck. To-day all is changed; men and women go to sea with the thought of the *Titanic* still in their minds, and the ship's life-saving devices are considered of paramount interest.

It is the object of this article to tell what wonders have been wrought in further safeguarding the life of the ocean traveller, and what clever life-saving devices have been invented to make ocean travel safer than before the disaster of 1912.

The sister ship to the lost vessel has had hundreds of tons of material built into her, and now she has a double hull extending up to well above the water line; thus, if she ran on the jagged pinnacles of a berg, as did her ill-fated sister, most probably the outer skin would alone be pierced, and the thick inner wall would continue to keep her water tight; in addition to this, the

thought of water rushing over the top of one bulkhead and flooding the next chamber (as happened on the *Titanic*), has caused the architects to raise the water-tight bulkheads right up to the upper deck. In all the liners now building these precautions have been faithfully carried out, and though the hull of the vessel is considerably heavier than previous to the disaster, the lower skin and double bottom are considerably stouter. To-day many modern liners not only have transverse water-tight bulkheads stretching across the ship from side to side, but, in addition, have a longitudinal wall of steel, from bow to stern, cutting the ship into two equal halves, so that if badly damaged on the one side the other is still kept water-tight.



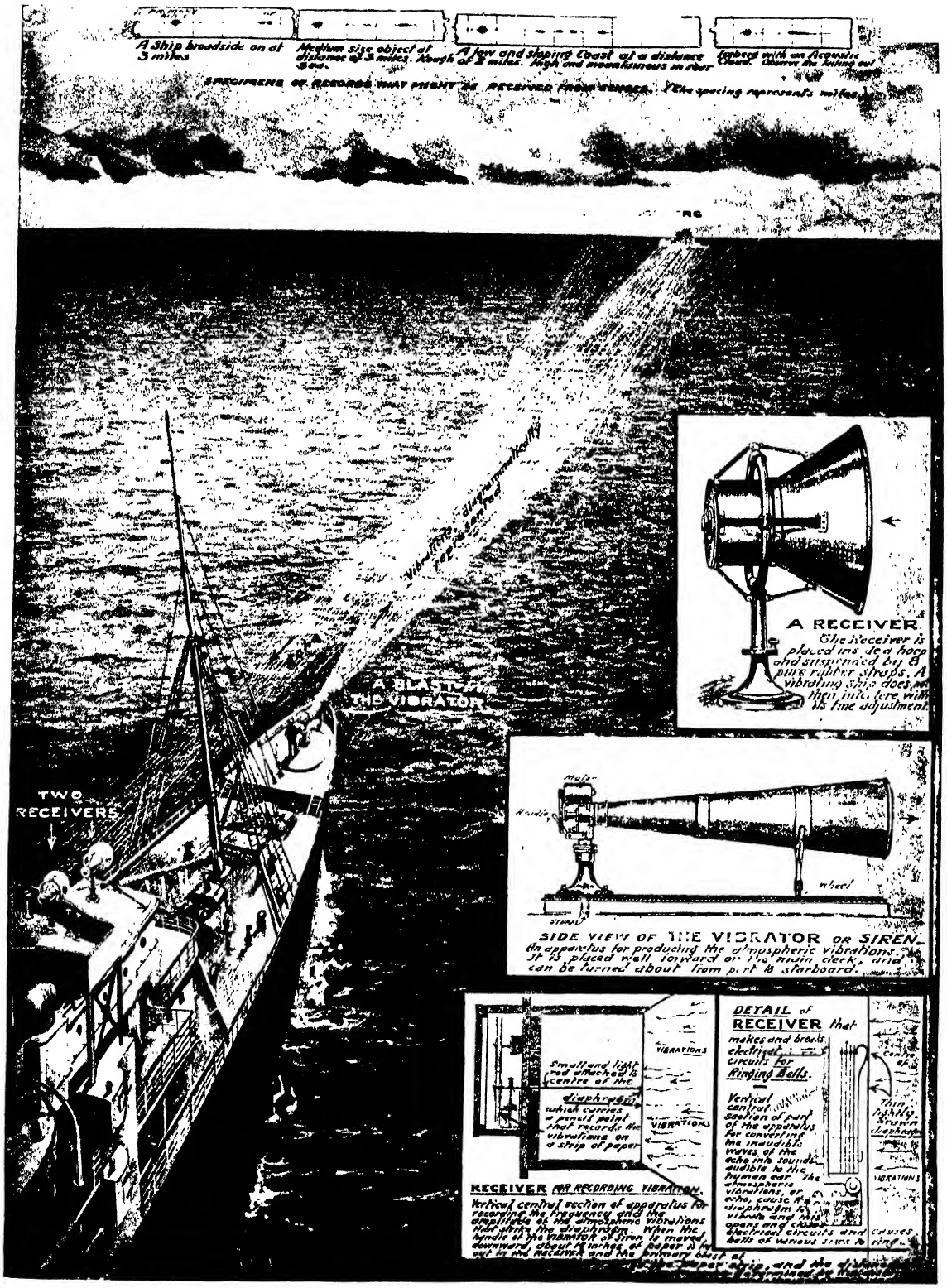
In the Crow's Nest

From their dizzy mast-head eyrie the look-out men keep vigilant watch. In case of danger ahead it is their duty instantly to ring the warning bell and telephone down to the officer on the liner's bridge

Of next importance is the question of the boats, and now that the Board of Trade regulations make it compulsory to carry sufficient boats to remove every person in the ship, naval architects have had to puzzle their brains how to store this extra array of life-savers, and also how best to carry the increased weight without affecting the stability of the ship.

To-day the *Olympic*—the *Titanic's* sister—carries no less than sixty-eight boats compared with the twenty previously; the new Hamburg-American liner *Imperator* has an imposing array of eighty-three boats.

In no other ship at the moment afloat is the installation of modern life-saving apparatus of greater interest than in this gigantic product of Germany. Firstly, the boats are not all placed upon the upper deck, for the lower promenade deck has been utilised to take eighteen of them. Longer davits are now fitted, for it must be remembered that, should the boats be on the upper deck, they have to be lowered from a height equal to a tall office building, and should anything of a sea be running at the time of the disaster, there is the danger of the boat being smashed against the ship's side. The *Volturno* disaster, however, brought to



The Collision Preventer—the Ship's Sixth Sense

(Drawn by W. B. Robinson)

Sir Hiram Maxim has invented a wonderful apparatus which, fixed in the vessel's bows, will give timely warning of danger from icebergs, derelicts, unsuspected land, or, in time of fog, approaching vessels. If a blast sent out by the vibrator, or siren, strikes against any distant object, the echo is caught up by the receivers, which indicate both the distance and direction of the danger

light the fact that the modern ship's life-boat was of little use in a heavy sea. Whilst the ill-fated emigrant ship burned a whole international fleet of magnificent

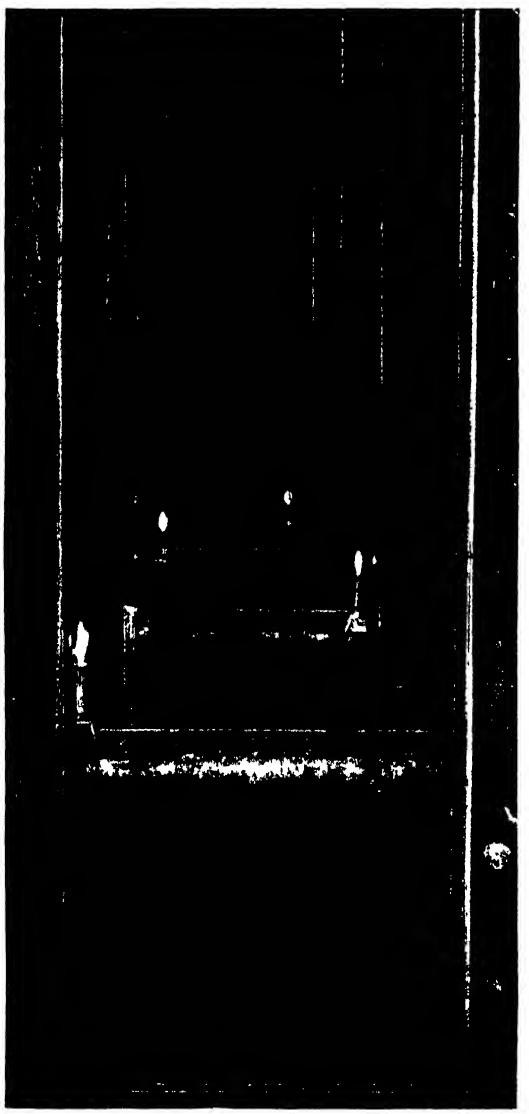


Photo Messrs Harland and Wolff, Ltd., Belfast

The "Olympic's" Inner Skin

A remarkable view of the water-tight space between the ship's outer shell plating and inner skin plating

liners surrounded her, but though they possessed scores of boats they were unable to help. We see, therefore, that even to-day, should a liner meet with a disaster in heavy weather, the possession of a hundred boats might be of no use to her, since they might be swamped or stove in during launching.

To overcome this serious difficulty, a new type of boat is now on the market, which has cork arranged all along the sides to act as fenders, and has, further, a double bottom divided by water-tight bulk-heads. Tests at sea have proved that, however hard they are smashed against their parent ship, they are in no way damaged, and so buoyant are they that they float uncontrolled in the very worst Atlantic weather. To protect the survivors of a shipwreck from the rigours of life at sea in an open boat, a decked-in life-boat has been invented and sold in goodly quantities; inventors have even gone further and invented "boats" taking the form of a submarine, and at least one of these devices has been tested at sea, with no little success. Mr. Axel Welin, the inventor of the davits that earned golden opinions for themselves at the time of the sinking of the *Titanic*, has invented a still larger boat of the unswampable type which is 50 feet long, 15 feet broad, and 7 feet deep, and will hold 250 persons. As this boat and full complement weighs 28 tons, it was apparent that new means for lowering had to be devised. This brought into being a davit of great strength, and caused the usual hempen ropes to be replaced by steel wires.

No doubt there is a great future before both the unswampable open and the completely decked-in boats; recently boats of the latter type have been constructed, each 42 feet long, and with comfortable seating accommodation, and with the occupants well protected from the weather. It is suggested that in a big liner seven of these larger boats would be slung from davits on either side, and fore and aft the funnels two tiers of boats would be placed across the ship, each boat fitted with minute wheels that move on rails attached to the deck, so that, if the

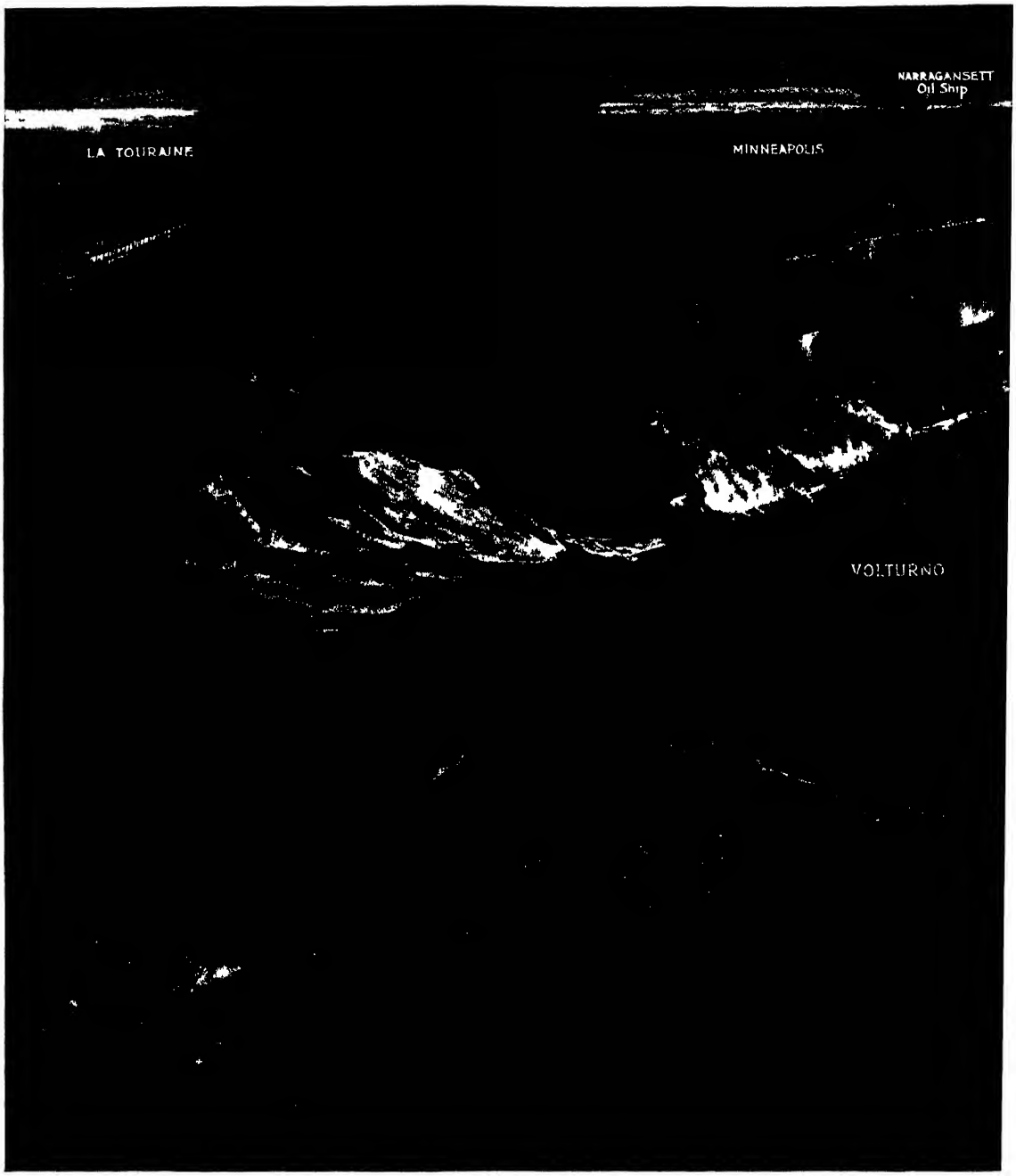
ill-fated liner is sinking on an even keel, half the boats would be lowered, one after the other, on either side. But should the ship have a bad list, then all the boats could be expeditiously placed in the water on the safer side.

In addition, four motor launches would be included in the ship's equipment, and these interesting little power craft (of which several types have already been tested), fitted with really powerful motors, would be well able to take the other boats in tow and draw them clear of the wreck: and, as these motor craft have a wireless installation, each can be separately calling for aid. Out of the eighty-three boats carried in the *Imperator*, there are only four with manilla rope gear, the remainder are fitted with wire ropes, and, in addition, have electric winches to lower the boats quickly. To provide ample current for the lowering gear there is a separate emergency power station with oil engines carried on the boat deck, so that they are quite independent of the main power plant. To give some idea how truly wonderful has been the progress in improving these life-saving devices, it is as well to add that, without any previous practice, boat after boat has been lowered, in many cases *by one man*, in the average time of fifteen seconds. Notwithstanding the fact that each of these boats can hold seventy-five persons and has to be lowered from a dizzy height, all apparatus can be operated with perfect ease by an untrained person

To further safeguard the ocean travelling public, other devices are now being universally fitted. To combat the terrors of fog is the submarine bell (described on pp. 277-281). To locate the presence of ice there is Laycock's ingenious device, consisting of a thermometer, which is immersed in the sea, the tube being pierced by electric wires leading to a bell and indicator;

A Liner's Wireless Room

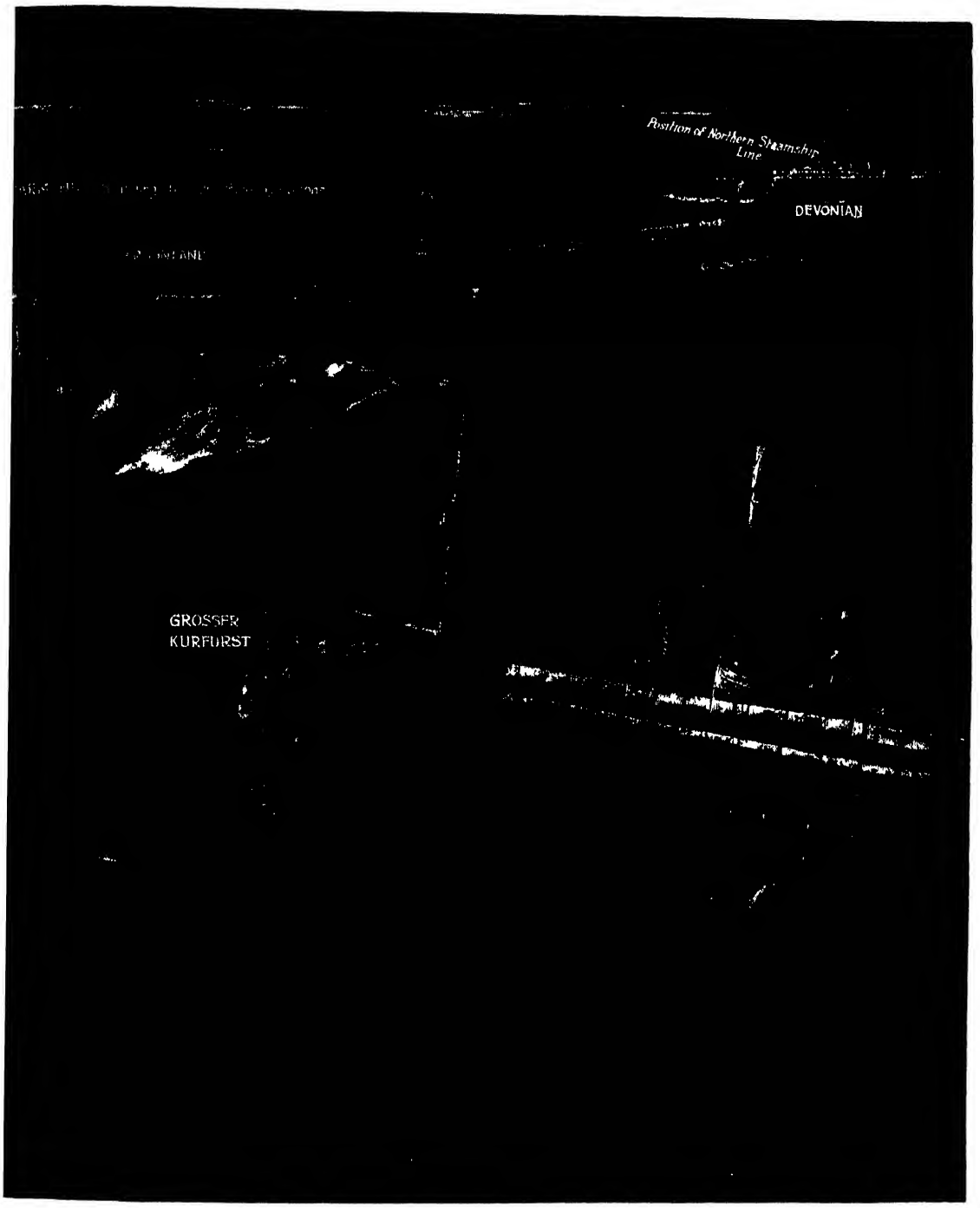
From this little room messages can be transmitted for hundreds of miles through the ether. Again and again, notably on the occasion of the *Titanic* and *Volturno* disasters, the "S.O.S." signal has brought help to despairing passengers



WONDERFUL GATHERING OF SHIPS OF ALL NATIONS, SUMMON

(Dra

The *Volturno* disaster brought to light the fact that the modern ship's life boat was of little use in a heavy
her It was long before the waves subsided sufficiently for life-boats to live an



BY WIRELESS TO THE AID OF THE BURNING "VOLTURNO"

G H. Davis)

Whilst the ill-fated emigrant ship burned, a whole international fleet of magnificent but helpless liners surrounded them. Will there ever be invented a small boat capable of braving the angriest storm?

immediately colder water is encountered, denoting the presence of a berg, a signal sounds automatically and the watch on deck is warned. The searchlight has been fitted in several craft, but has yet to prove its worth for detecting danger ahead.

In case of fire, powerful pumps are fitted. On the occasion of the great fire on the *Imperator* at New York on August 28th, 1913, 15,000 tons of water were quickly pumped into the vessel without wetting the neighbouring compartments; and, remarkable as it seems, the steerage passengers were landed at the same time *without one of them knowing that any fire was raging.*

In the more important disaster to the emigrant ship *Volturno* in October, 1913, the horrors of fire at sea were brought very vividly before the eyes of the public. It must be remembered, however, that the *Volturno* was a small and comparatively old ship, and in all modern vessels the fire-fighting appliances are so efficient that it is hardly likely that such a disaster could befall a big passenger boat. Pipes are run to every part of the ship, and in case of fire the portion in flames would be closed up and the conflagration smothered by carbonic acid, or sulphur gas, in a matter of moments.

It is well recognised that no liner can be made absolutely unsinkable, yet as a result of the *Titanic* disaster expert brains and hands have got to work, and to-day the modern passenger ship is continuously adding fresh safeguards against her hidden foes—the iceberg and the derelict. With the help of the submarine bell and wireless telegraphy we are conquering the horrors of the fog banks.

As for rough Boreas and his heavy seas, the modern liner fears them little to-day, owing to her size, strength, and sea-keeping qualities.

Diatoms

Symmetrical Minute Sea Plants

By HAROLD S. CHEAVIN, F.R.M.S.

AMONGST the numerous minute marvels of Nature found in the sea, and unseen by the naked eye, are the wonderful symmetrical structures known as diatoms. For considerably over a hundred years investigations have been carried out by naturalists, and expeditions have been sent out to gather information about these minute forms of plant life.

In sunny weather some diatoms are found on the borders of the sea, especially on the stretches of mud flats which are left uncovered at low tide. But the largest number of varieties are found on the surface of the sea, during the first few months of the year, and they are collected by means of very fine silk nets or bags.

Many of the expeditions sent out to collect these wonderful diatoms work entirely round our own shores, especially in the North Sea and the west coast near the Clyde.

The collecting nets are shaped like a large sausage, and, when let down into the water, they are rapidly filled with a light brown scum, which resembles in its consistency soft soap. On drying, this scum hardens into a felt-like mass.

These minute plants occur in such abundance in the sea that they may be termed

or looked upon as the pastures for the small forms of animal life found in the ocean.

The small forms of marine life which feed upon diatoms include shrimps, prawns, external parasites, sea-squirts, and sea-cucumbers. Even shell-fish are partial to them, including the well-known oyster; many other forms of fish, also, when opened have been found to have diatoms present in their alimentary tracts.

Many rare forms of diatoms are found present in the large quantities of guano deposited by fish-eating sea birds off the Peruvian coast and elsewhere.

In his observations on "The Southern Seas," Sir J. D. Hooker states that within the Antarctic circle diatoms become enclosed in newly-formed ice, and they are washed up in myriads by the sea on to the packs and bergs, where their presence makes the snow and ice a pale ochreous brown.

Having a preference for cold water, the presence of these minute forms of vegetation throughout the Southern Ocean is a most important factor, since there is in this region a marked deficiency of the higher forms of plant life. Were it not for their occurrence there would not be sufficient food for the marine animals. Furthermore, the ocean waters could not be purified from the carbon dioxide gas which is being constantly expelled by animal respiration and decomposition.

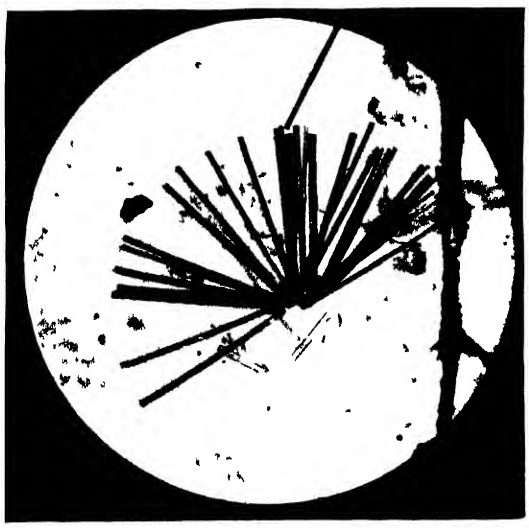
Reproduction by Simple Division

The top diatom is just completing the process; that on the left is commencing it

Diatoms are found distributed widely. Vast deposits formed of the accumulations of the remains of enormous numbers of diatoms which lived many thousands of years ago occur in various parts of the world.

To illustrate the enormous magnitude of these deposits, one could give many examples; the accumulation on the flanks of Victoria Land has been found to be 400 miles long and 120 miles broad, at a depth of 200 feet to 400 feet; its thickness is so great that no measurement has been made. The deposit of fossil diatoms at Bilin, in Bohemia, is about 14 feet thick, and Ehrenberg, a famous student of diatoms, estimated that over 40,000,000 of these minute plants were present in every cubic inch of it.

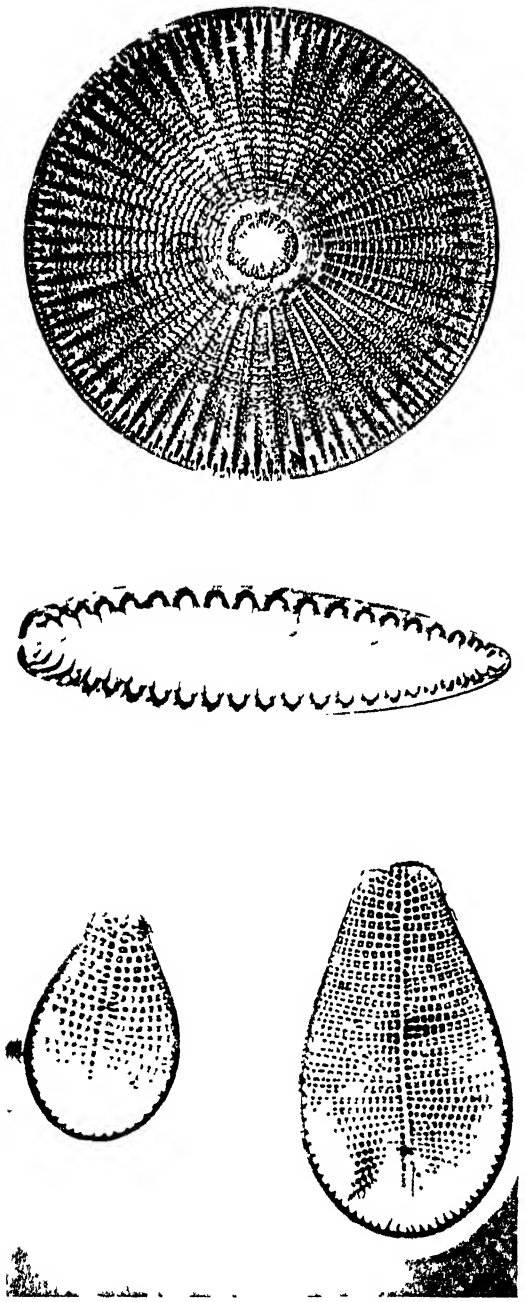
Fossil diatoms are not of interest exclusively to the scientist. They have also some economic importance, and are utilised for the making of polishing powders and non-conducting materials, as absorbents for nitro-glycerine in the manufacture of dynamite,



Fan-wise Formation after Reproduction

The dark, thick line at right represents *Rivularia*

tooth powders, and many other substances. The vast quantities found in Scandinavia are called by the natives "bergmehl," or mountain flour; and it is confidently stated that the people in certain districts find it of the greatest use in times of scarcity for mixing with their flour when making bread This does not, as one would naturally suppose, merely increase the bulk of the flour, without adding nutritive qualities, for the "bergmehl" loses at least one-third of its weight when exposed to heat, thus showing that it contains a large quantity of organic matter.



Three Beautiful Diatom Types

1 Found in Japan and California
2. From the Bass Straits of Australia
3 Rare flask-shaped *Podocystis Adriaticus*

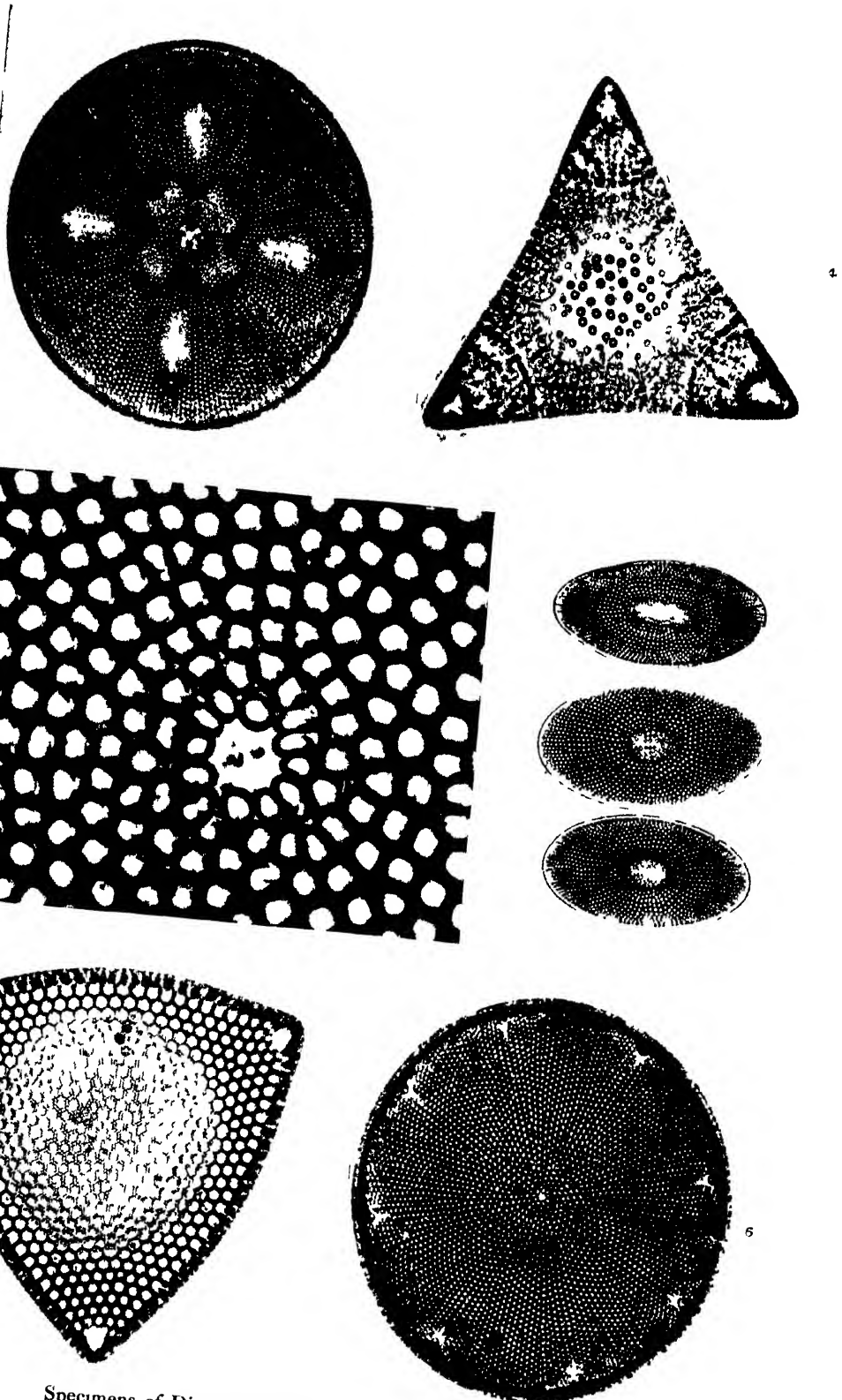
The longevity of these minute plants in the living state is very remarkable, and they have been known, in the case of some species, to survive for nearly twenty-five years in their natural element, though kept for long periods in the dark. Miquel found that they could thrive in water at freezing point, though their vitality was destroyed at very low temperature. On the other hand he found a high temperature equally harmful to them.

It is interesting to note that the origin of diatoms, and their many minute companions of an animal nature in the ocean, such as the Radiolarians, is traced to a common ancestor in which the differentiation of vegetable from animal characteristics had not been attained.

The earliest forms of diatoms floated on the surface of the ocean, and, having no power of self-locomotion, they were drifted haphazard by the winds and waves.

The evolution of the land forms of these minute plants has provided investigators with one of the most interesting problems ever taken up by scientists. It has been observed that the marine types, in their gradual transmission from the sea, have produced new species by slowly assuming a new shape, and this has resulted in the diatom being endowed with the power of movement

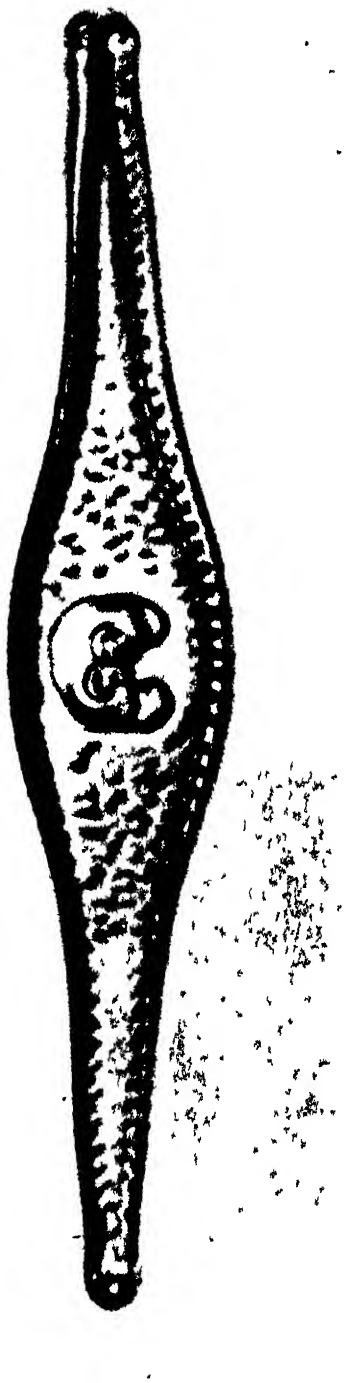
This movement, or self-locomotion, has not been developed to enable these marvellous structures to escape from their enemies, but simply to give them an advantage in their struggle for existence. One could write many pages about this



Specimens of Diatoms Magnified from 500 to 1,000 times

1 The Cross diatom from Peru
2 Photo-micrograph of central portion of 6
3 A good example of hexagonal formation
4. Triangular diatom from New Zealand
5 Semi-boat-shaped specimens from Barbadoes
6 A fine specimen of dot formation

wonderful story of the adaptation of the diatom, enabling it to live in streams, and how diatoms, taking a boat-like shape, found their way up the various estuaries and rivers into the internal waters of the land—marshes, lakes, and pools.



A Californian diatom magnified 3,000 times. Observe that it is made up of two perfect fitting shells or valves

The most remarkable feature of all is to be seen in the land forms, which show that, once they became established, the form of the diatom changed, and each shape was particularly suited to each environment.

"What precisely are diatoms?" the unscientific reader may ask. They are members of a large group of plants, of very simple structure, known as *Algæ*, which are found almost the world over in waters of a fresh, brackish, or salt nature. They also occur on stones, placed in moist situations.

The large number of varieties of seaweeds found on the rocks in the sea are representatives of the *Algæ*. Diatoms are found, in many cases, attached to the large flat surfaces of the weed seen waving about or floating in the waters of the ocean

The familiar green slime so often seen on the surfaces of pools, where the water is practically still and becomes somewhat stagnant, contains many forms of these *Algæ*, including diatoms.

Up to the present over 10,000 varieties of diatoms have been discovered, named, and catalogued; each year brings fresh additions, according to the number of investigations carried out The study of these minute plants has been taken up by an enormous body of microscopists, and to-day this particular branch of work is, if anything, more popular than ever.

What constitutes the structure of a diatom, and how does it live?

A diatom is a very minute plant, and its size is best expressed by stating that hundreds could be placed on the head of a small pin. To the naked eye they appear, when a large number are present, as specks of fine dust, greyish in colour; whereas in the living state, unless gathered together in large numbers, some of the species are

invisible without the aid of the microscope.

The study of diatoms in the living state is only carried out with difficulty, and the greater part of our information concerning them has been derived from the frustules, or hard shell cases composed of silica, of the fossil forms found in the deposits already mentioned.

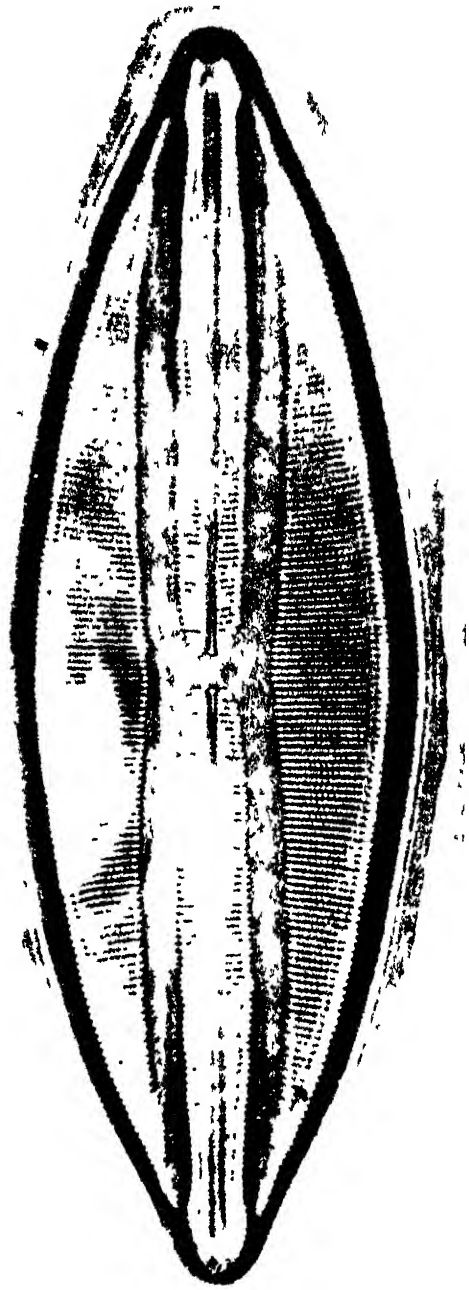
The structure of a diatom is very simple. It resembles two lids fitting together, as shown in the photograph on p. 606, and these lids, or "valves," as they are termed, are held together by hoops placed at their margins.

When in the living state, the diatom has, outside the frustule or two valves, a jelly-like envelope of mucilaginous substance.

The frustule is of the greatest importance to the observer, for it is by means of the regular markings found on the surfaces that the species of diatoms are distinguished from one another. Some of the frustules have on their surfaces very fine lines in great number; others have equally fine dots, whilst many forms have circular, rectangular, or oval-shaped spaces present. The most noteworthy and marvellous point about these minute markings is that they are all placed at regular distances and geometrically perfect in their distribution. Wonder is still further increased on further magnification, when it is found that beneath these dots there are secondary dots, and possibly there may be yet more structures underneath.

To return to our description of the structure of the diatom, we find that between the lids is enclosed the living substance found present in all living bodies, known as protoplasm. This protoplasm in the diatom is of a brown colour, due to a brown granular substance which can be extracted and is known as "diatomin."

This diatomin acts in exactly the same manner as the green colouring matter found present in land plants especially, which can also be extracted and is known as "chlorophyll." The functions or duties of both substances is to take in the carbon



Diatoms, as found in the sea, are generally of a circular form, but as they find their way into still inland waters they assume a new shape. This particular form (magnified 1,750 times) has the power of self locomotion. Observe how it has become elongated and shaped like a boat, so that it can travel through the water easily

Fossil Diatoms from Scotland

dioxide of the air or water, and by a process known as "photo-synthesis," use the gas for building up their body substance.

In the protoplasm there are also present many other bodies in granular form, such as oil globules; it is interesting to note that the presence of these oil globules in those diatoms found living in drinking water cause, in many cases, the fouling so often experienced in country districts. The most important body present in the protoplasm is the nucleus, which represents the vital force of these minute plants; it is due to its presence that the diatom can propagate its species.

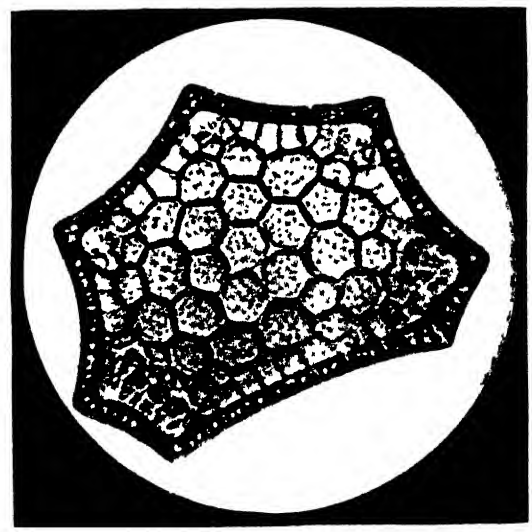
The modes of reproduction in diatoms are both simple and remarkable. The most frequent method is by simple division. In a very short space of time many new ones are produced, by the simple process of breaking off from the parent, as illustrated on p. 603.

Another method is by the formation of auxospores, each of which gives rise to a new individual.

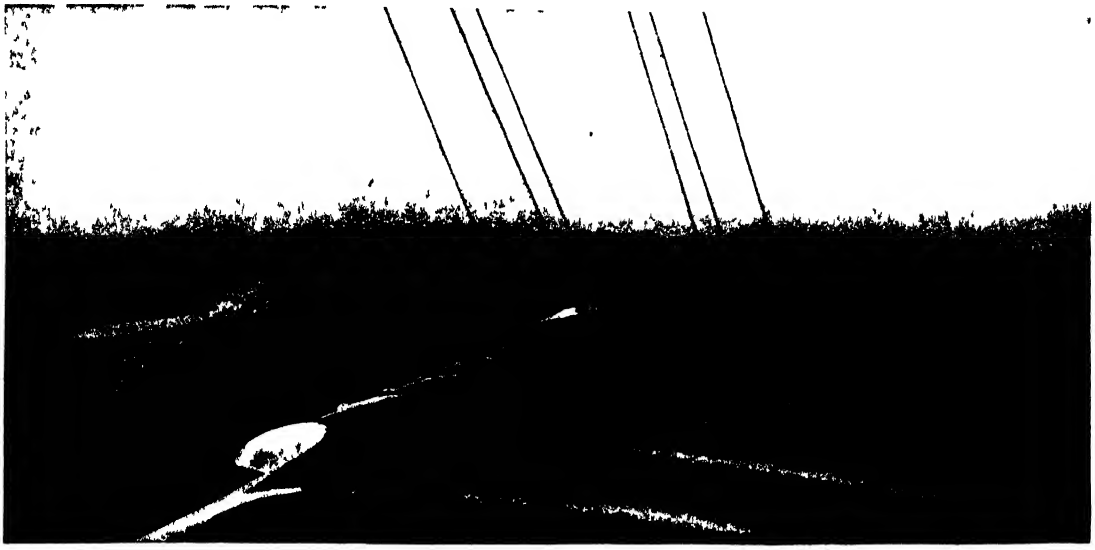
In simple division a notable feature is that, as the process of reproduction continues, the new diatoms become smaller and smaller. If this were allowed to continue long enough, we should reach a very awkward state of affairs, but here, at this juncture, Nature steps in, and this form of reproduction for the time being ceases. The parent diatom becomes dormant, and another diatom, in a similar state, belonging to the same species, fuses with the former, and they remain fused for a certain period. This fusing eventually comes to a termination, and the diatoms, having separated, continue their propagation of new individuals by their old method.

With regard to the movement of diatoms, it is found that this power is only possessed by isolated species, of which many wonderful stories could be given. It is amusing to watch how they push away small objects during their locomotion, but in the case of large objects they remain for a short time pressing hard against them, till, finding their efforts are futile, they turn round and retrace their course.

Diatoms have been estimated to move through a space of four hundred times their own length in three minutes. A specimen $\frac{1}{100}$th of an inch long moves $\frac{1}{40}$th of an inch in each second. Some of the movements found in diatoms are very slow, and give the observer an impression of creeping; others appear only to rotate about a fixed position.



An Interesting Variety



M. Dancourt crossing the Danube

Nature's Aviation School

Animal Aeroplanes on the Study of which Man has Based his Machines

By W. S. BERRIDGE, F.Z.S.

THE much-vaunted superiority of man over the lower animals is apt to prove somewhat valueless when we compare their relative powers of sustaining themselves in the air; and although we have certainly made vast strides in the art of flying during late years, yet, nevertheless, we have still a lot of leeway to make up before we can vie with them in this respect. In one feature, however, the human animal has shown himself as being superior, for it has now become almost a commonplace to read in the papers that an airman has performed the remarkable feat of flying upside-down.

Whether it would be possible for a bird or other creature to emulate such tactics is open to doubt; but in any case, as they only utilise their powers of flight in order to get about from one point to another, and are entirely indifferent to the fame attached to the accomplishment of sensational exhibitions, there is little probability of their attempting it.

Although, strictly speaking, all manner of living creatures are included under the title of "animals," yet in the scope of the present article it is the intention of the writer to confine his remarks to other creatures than birds and insects, whose powers of flight are so familiar to all as to need no further comment. It is, however, in dealing with certain mammals, and even fish, that the wonders of flight are shown in a somewhat unusual manner, for normally these creatures are, like man, chiefly adapted for a terrestrial or arboreal existence, or else for a life in the water.

There is only one group of mammals that is endowed with the powers of true flight, in the sense of being able to sustain themselves in the air by an up-and-down motion of their wings; and these are the *bats*. Indeed, so specialised are these animals in

(*Drawn by G H. Davis*)

Man can only Fly with the Aid of Complicated Mechanism

Whilst in the air the anxious human aviator must be incessantly watching against a host of dangers, and moving this lever and that to adjust his machine to varying conditions. He will not really be master of the air, until, like the animal aviator, he has achieved automatic stability

Nature's Aviation School

Artificial

The Bat—an Aviation Expert

Though originally a creature that walked the ground like any other animal, the bat has transformed itself into a perfect flier

structure, that they are to-day only suited for a life in the air, and upon the ground their movements are extremely laboured and ungainly.

It is, however, a generally recognised fact that the ancestral form of these creatures was of ordinary terrestrial habits.

The power of flight in the bats is brought about by the great elongation of the fore-limbs and digits, over which is stretched a covering of membrane-like skin; and in many cases this skin is carried to the extremity of the tail, although this is by no means a constant feature. The largest species of bats are known as fruit-bats or flying-foxes, the latter term being applied to them on account of the fox-like appearance of the head; the accompanying illustration (top of p. 616) shows the Malayan flying-fox or Kalong. This bat grows to a greater size than any other, and has a wing-spread of as much as 4 feet. Its flesh is greatly appreciated by the natives as an item of their diet, and a reference to its edible qualities is given by its Latin name of *Pteropus edulis*.

A quite distinct type of mammal endowed with the means of flight, and which may truly be termed "animal aeroplanes," are those that obtain their powers of aerial locomotion by the possession of flaps of skin attached, on either side, from the fore limbs to the hinder ones, which are stretched out to their full extent when the animal leaps or glides through the air. This flight or glide is always taken in an oblique and downward direction, although it appears that the body of the creature is poised with the head uppermost; and not, as commonly supposed, pointing downwards.

Some of the most familiar of this type of animal are the Australasian marsupials known as flying-phalangers or flying-opossums, although, strictly speaking, the latter term should only be applied to the American opossums. A well-known example is the squirrel-like phalanger, or, as it is often called in its native country of Australia, the sugar-squirrel—a beautiful

Photo W. S. Berridge

Flying Frog

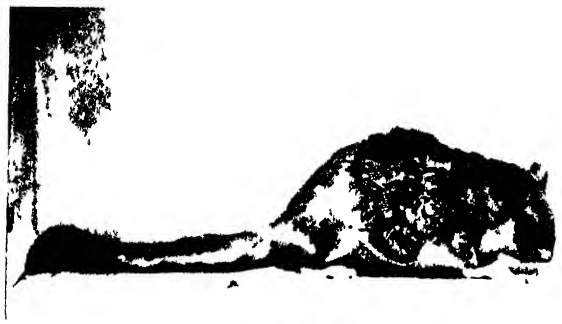
Observe the membranes uniting the toes

ANIMAL AVIATORS, FROM THE STUDY OF WHICH MA

(Drawn from the Specimens Exhibited at t

MAY HOPE TO PERFECT HIS POWERS OF FLIGHT

tural History Museum, by W. B. Robinson)

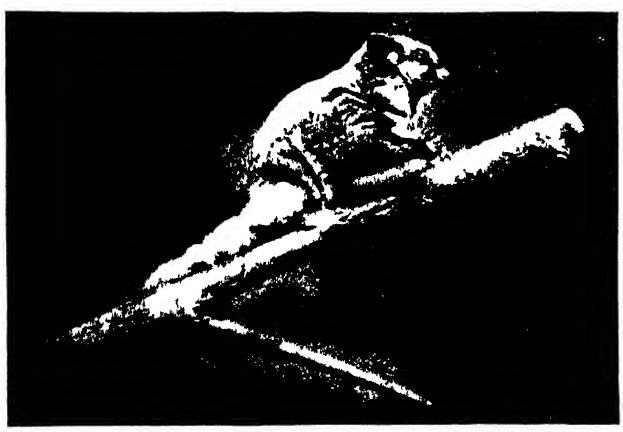


American Flying-Squirrel

little animal with remarkably soft fur; whilst yet another is the short-headed phalanger.

The cobego of the Malay peninsula is a further example of an animal possessing a parachute-like membrane of skin utilised for sustaining flight; it differs, however, from the foregoing in the fact that the folds of skin are extended from the fore-limbs to the neck, and from the hind limbs to the extremity of the tail. A fuller reference to this remarkable creature will be found under another heading.

Among the rodents we find American flying-squirrels characterised by the possession of flight-sustaining membranes.



Short-headed Phalanger

We will next review a group of lizards that are known by the somewhat alarming name of flying-dragons.

These reptiles are at once distinguished from all others of their kind by the possession of a curious wing-like and membranous outgrowth of skin on either side of the body, which derives its necessary support from an elongation of the hinder ribs, the reptile having the power to expand or fold up the wings at will. A well-known example of these remarkable creatures is the Malay flying-

Squirrel-like Phalanger

lizard, which measures rather more than 8 inches in length. It is of very beautiful colour, the upper surface of the body being of metallic and varying hues relieved by dark bands and spots, whilst the wings are orange in colour with irregular markings of black.

These lizards live entirely amidst the trees, and their flight is so rapid that it is stated to be almost impossible to discern their wings during their passage through the air.

Other marvels of the reptile world are the extraordinary flying-frogs, with such enormous membranes

Photo Wade and Keen, Madras

Indian Flying-foxes Roosting Upside Down

These and other members of the bat tribe are the only mammals which have so far won the full power of flight—i.e., the ability to maintain themselves in the air by flapping their wings

Photo H. S. Berridge, F.Z.S.

Malayan Flying-fox or Kalong

It has a wing spread of 4 feet

stretching from toe to toe that, by their use, the animal is able to take flying leaps. Although there are a number of different species, yet the Bornean flying-frog can be taken as a typical example. The fingers and toes of this creature are of great length, and webbed to their extremities; and when expanded the area of resistance offered to the air during flight exceeds that of the body. Furthermore, small strips of membrane-like skin are also attached to the fore-legs along their sides. The body is also capable of being inflated, which gives a further degree of buoyancy during flight. Mr. Wallace, in his writings of this species, states that their body measures 4 inches in length, and that the fully expanded webs of each hind foot cover a surface of 4 square inches.

In conclusion, reference must be made to the flying-fish, of which the common species is known in the scientific world as *Exocœtus evolans*. In general appearance they resemble herrings, and in length usually measure about 10 or 12 inches.

Their pectoral or breast fins are highly developed, and act as wings during their progress through the air. Another species of fish endowed with the power of making short flights is the flying-gurnard, which differs little from the familiar red gurnard except for the remarkable growth of the pectoral fins, which are converted into the most serviceable wings.

An interesting fish that was discovered in the Victoria River, Cameroon, in 1874, is the butterfly-fish, or fresh-water flying-fish, of tropical Africa. Only one specimen has ever been seen alive in this country. We are indebted to the naturalist De Brazza for his observations of this fish during a visit to the Congo, when he captured one in a butterfly net in mid air.

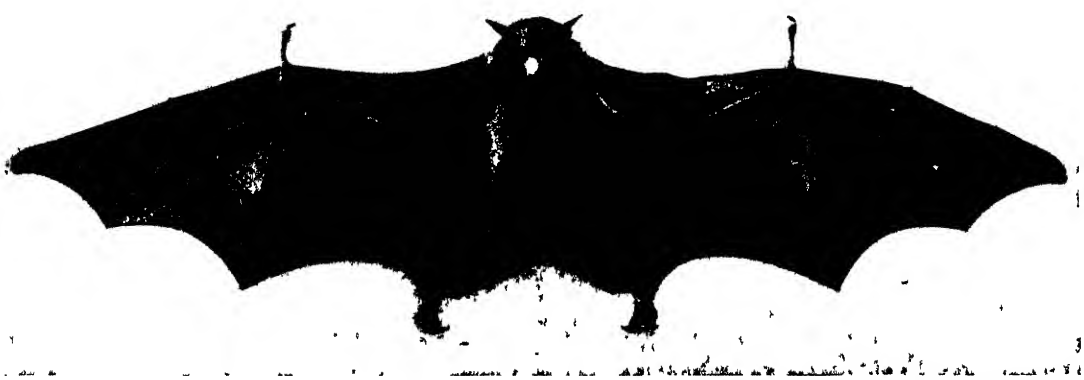


Photo Wale and Kane, Madras

A Flying-fox with Wings Widespread

This creature's ancestors walked the earth like other mammals. Will man ever contrive to adapt his body so marvellously for the air?

Chimpanzis at Table

Man's Nearest Relations

Concerning the Gibbon, Siamang, Orang, Chimpanzi, and Gorilla, all of which are Nearer to Man in Structure than they are to Monkeys

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

THERE can be no possible question as to the nearest relations of Man. They are the Anthropoid Apes still lingering in the forests of West and Central Africa and Eastern Asia. These creatures - the Gibbon, Siamang, Orang, Chimpanzi, and Gorilla—are nearer to Man in structure than they are to the Monkeys. They are, in fact, his blood relations, inasmuch as the composition of their blood is virtually identical with that of human blood. The differences between Man and the Anthropoid Apes are perhaps most fairly gauged by their separation into two distinct Families in the order of the Primates—an order which also includes the Baboons and Old World Monkeys, the American Monkeys and Marmosets, the Lemurs and Tarsiers. Apart, however, from the enormous difference in volume between the human brain and that of the anthropoids, and the fact that Man is in his higher developments almost a god, while the anthropoid ape remains a brute, it is questionable whether systematists are not overestimating the purely physical differences between men and apes when they place them apart in separate families. With the discovery of further "missing-links" the genera *Homo*, *Eoanthropos*, and *Pithecanthropos*, may only form a sub-family of anthropoid primates.

In the conformation of his skull and limb-bones, musculature and viscera, Man comes very near to the apes. He is naked and they are hairy; yet this distinction does not prevent the Mammoth—covered with thickly-matted hair—from being in the same genus with the Indian Elephant,

whose hair in the adult is reduced to a few bristles on the tail. But the differences between the *Hominidæ* and the *Simiidæ* have a certain obstinate importance which cannot be bridged in time by less than a million years of separation, possibly two million. It must have required at least a million years to make Man as we see him to-day in the one surviving species, *Homo sapiens*.

Photo Sir H H Johnston

Schweinfurth's Chimpanzi

Of the existing anthropoid apes the chimpanzi is the one that approaches man most nearly in regard to teeth and brain

The points in which men of the genus *Homo* differ from the lowlier anthropoids are chiefly concerned with the proportionate size and weight of the brain, the reduction of the canine teeth and of the jaws, the power of articulate speech (and the changes it has involved in the chin, the tongue muscles, and the brain), the structure of the foot and hand, the proportion that the hind limbs bear to the arms, the development of the nose, the size of the pelvis, the curve of the spine, and the configuration of the liver and other organs of secretion and excretion. Of the existing Anthropoid Apes, the Chimpanzi is the one that approaches Man most nearly in regard to teeth and brain, while the Gorilla is the nearest, judged by the structure of foot and hand, nose, and internal organs. The Orang, though it has many human character-

istics in disposition, intelligence, and facial aspect, and though its skull when young is distinctly human in proportions of brain-case to muzzle, nevertheless has deteriorated from the ancestral type which originated man and the larger anthropoids, principally in the very poor development of the nasal bones, the thumb, and the big toe. The Gibbons, though they are probably at most slightly divergent descendants of Man's great grandfather in the middle Miocene, are more monkey-like than the other anthropoid apes. As regards means of progression they come nearer to the erect bearing and walk of Man than the Chimpanzi, Orang and Gorilla. But they have developed their arms in length to an extravagant degree from the habit which has grown with them for about two million years (at a guess) of passing their lives exclusively in the forest and progressing chiefly by the methods of the trapeze performer who leaps from one hand-hold to another. The Gibbon-like ancestors of Man must have taken to a ground life—quite possibly in Egypt, Syria, or Mediterranean Europe, at some period when the forests were lessening and more desert-like conditions supervening. They had already acquired the bipedal progression of the modern Gibbon (in fact, in this respect the Chimpanzi, Orang, and Gorilla, who walk with difficulty on two legs, and frequently support themselves on the ground with their knuckles, have degenerated), and as with less and less attachment to the forest their arms grew shorter in proportion to the longer hind limbs, the hand began to be used not as a means of progression, but as the instrument of the brain. Monkeys and baboons can use their hands with some deftness, so can lemurs. Indeed, the human "idea" started far back in the history of the mammals in some possibly marsupial creature which took to a tree life to avoid its enemies, sat upright and stood upright and used its hands —already divided into a thumb and four fingers—to investigate crannies in the search for insects and birds, to pull flowers and fruit to pieces, and even —as may be seen in the African Galagos at the present day—to box with their rivals

Photo: The New York Zoological Society

The Bald-headed Chimpanzi of Loango

and enemies. There is little doubt in my own mind that the Orang, Gorilla, and Chimpanzi are degenerates; they are the descendants of unsuccessful, collateral, semi-human types that regained the forest and reverted to a brute life at the time when their more human brothers of the

open country were shying stones, digging with sticks, and hurtling clubs through the air—clubs that in course of time evolved into the boomerang.

Beyond the Gibbons—whose range is restricted at the present day to the Eastern Himalayas, Indo-China, the Malay Peninsula, Sumatra and Java- we seem to catch glimpses of a monkey-like creature which existed in the Valley of the Nile, in the long Eocene period, and though of small size, combined distinct anthropoid or even human characteristics with others reminiscent of the American monkeys (*Cebidæ*) or of the *Colobus* group in the Old World. Vestiges supporting such ideas have been discovered by Professor Fraas of Würtemberg, and other scientific explorers in Egypt. Already zoologists had detected in the African Colobus monkeys (which are closely allied to the great *Semnopithecus* group of Asia) a certain likeness to the American Monkeys, and to remarkable extinct forms in Madagascar which may be said to have combined the features of Old World and New World monkeys with those of Lemurs. From other knowledge we possess we may hazard the guess that the first Primates, the first differentiation from an early, somewhat marsupial type of mammal into a Lemur-like beast, occurred either in Northern Europe or North America. Lemurs, large and small, not markedly dissimilar from those found living or extinct in Madagascar, once inhabited England and France. They would seem to have passed through, in Africa, during the course of the Eocene period, a phase resembling that of the American or Platyrrhine Monkeys, which, indeed, arose from this improved Lemurine type and crossed the ancient land-bridge connecting West Africa with Brazil. Here they developed into the Sapajous, Howlers, Spider Monkeys and Marmosets of to-day; while the ancestral stock in Africa grew into the Catarrhine type of

Photo W S Berridge, F Z S

The Chimpanzi not only Sings but Laughs Unmistakably

monkey, baboon, and macaque. In North-East Africa, apparently, the ancestral forms of Old World Monkey, in addition to the other diverging offshoots, gave birth to the first anthropoids, the last move but one in the final evolution of Man.

Where the attainment of completely human characteristics was consummated in the birth of the genus *Homo*, we do not yet know. Something very near the missing link between Man and the Anthropoid Ape has been found in the late Pliocene formations of Java, and named *Pithecanthropos erectus*, because its brain and skull-case were half-way in volume and form between those of the anthropoids and of man, and because its thigh-bones show that it could walk more or less erect, though no doubt with a shambling gait. But although the lowest existing races of humanity are to be found in Australia (and formerly in Tasmania) they, like *Pithecanthropos*, may only have been refugees in these remote regions from the too active competition going on in Asia and Europe. A very primitive human type, *Eoanthropos* outside the genus *Homo*—existed in our own Sussex at the close of the Pliocene or commencement of the Pleistocene. *Eoanthropos dawsoni* had a completely human brain, but larger, more separated and pointed canine teeth, and an ape-like chin, lacking the features associated with articulate speech. The divergent men of the Neanderthal race (*Homo neanderthalensis*, an offshoot from the primitive human stock, and *not* an ancestor of *Homo sapiens*) are being dealt with in another article. In this we are not considering human species, typical or divergent, but the nearest living relations of the human family, and these are the apes I have enumerated.

Photo U. S. Ferrari & Co.

The Chimpanzi is the Most Likely to Survive of all Man's Poor Relations

As regards voice, it has been thought by some zoologists that the Gibbon—lowliest of the Anthropoids—came nearest to humanity because of its extraordinary powers of singing in a cadence of two or three notes. But it has seemed to the present writer, who has had a long personal acquaintance with African apes, that the Gorilla or the Chimpanzi are more human in their utterances than the Gibbon. At any rate, in regard to the Chimpanzi, it sings in a rude fashion, it laughs unmistakably (a hideous cachinnation), it screams, whimpers, coaxes, and pleads. Some chimpanzis seem actually to articulate a sound like *um* or even *ma*, and to do it in appealing to some human foster-parent. In fact, only the other day I made the acquaintance at Mr. John Hamlyn's establishment at the London Docks, of an interesting chimpanzi child, which had become extraordinarily attached to Mrs. Hamlyn, and distinctly greeted her with a sound like *um-ma*, made by its protruded lips.

An Aged Orang-utang from Borneo or Sumatra

The orang is docile and contented as a captive, but seems to become dulled in mind. This wonderful old man of the woods was presented to the Zoological Gardens at Amsterdam by the Sultan of Serdang

So far it has been almost hopeless to keep and train the Gorilla in captivity, because it is exceptionally susceptible to germ-diseases and changes of temperature, and appears moreover to resent captivity as bitterly as any sensitive human being. The Orang is docile and contented as a captive, but seems to become dulled in mind. On the whole, the most likely of survival and of adoption by the human race as a domestic animal or poor relation is the Chimpanzi, which of late has taken a leading part as a music-hall and circus performer There have been, as we know, a whole series of "Consuls" on the variety stage. I well remember the first of these Consuls, who was a singularly intelligent chimpanzi, obtained from Portuguese Guinea, between the Gambia and Sierra Leone. He had become the property of a colonial official then administering the Gambia Government, and for some reason had been nicknamed Consul—it was said after myself, because I was at that time a consul on the West Coast of Africa, and made the journey to England in company with this interesting ape. "Consul I." travelled (and behaved with perfect decorum) as a first-class passenger. He was sold to Mr. Cross at Liverpool soon after landing, and, if I am rightly informed, he was the first noted trained performer. In course of time he died, and has been succeeded by three or four others bearing the same name. It would be of great interest to students of the Anthropoids if all those *impresarii* who have had the training and exhibition of these "Consuls" would unite to describe quite faithfully their home life (so to speak); how far they acquired any permanent habits of civilisation, how often and how much they relapsed into brutishness, the diet that suited them best, and the conditions of life under which they lived longest.

In their native wilds chimpanzis live in troops or even tribes. I have shared the forest with them sometimes when they seemed to be in considerable numbers. On moonlight nights they would be very noisy with their hooting and shouting, and I have heard a drumming sound which has likewise been recorded by Emin Pasha,

Remarkable Speciman of Large Male Orang-utang at Stuttgart, Germany

and is stated by the negroes of the forest to be made by the chimpanzis thumping with their fists the many prone hollow trunks of trees which lie about the Congo forest trees that have fallen and have gradually been excavated by white ants and boring insects.

The Orang, Chimpanzi, and the Gorilla, all build platforms or nests as resting- or sleeping-places in the trees. The Gorilla's nest, at any rate on behalf of the male,

DERIDED BY WOMEN! THE END O

After killing one man and seriously injuring another at Nola, in Equatorial Africa, this gorilla was slain, and t
of the warric

A GORILLA IN EQUATORIAL AFRICA

women of the village painted their faces and sang a pean of triumph over the vanquished, praising the heroism who laid it low

Young Female Gorilla

Resents captivity like a human being

seems to be a bed-like platform of sticks, stems, and long leaves, which is made at the base of some mighty tree. There is a specimen of such work in the Natural History Museum at Paris. It is said that the female gorilla passes the night up the tree, whilst the male reposes below. Male gorillas, indeed growing as they do sometimes to a height of six feet, with an enormous breadth of shoulders—are not nearly so arboreal as the females of their species or as the chimpanzi—still less so than the orang, which is a tree-loving animal that dislikes to visit the ground. The male gorilla probably very seldom ascends a tree. It lives chiefly amongst the undergrowth, and is so powerful and so ferocious that no animal but man is likely to attack him. As late as the opening years of the twentieth century, gorillas were still in such abundance and so fierce and truculent in the southern Cameroons, that they actually prevented for a time the exploration of certain forest regions which were totally uninhabited by man. Negroes did not dare to enter these forests to clear and cultivate because they were assaulted by the gorillas; and even white explorers were attacked.

The range of the gorilla is now found to extend right across the equatorial belt of Central Africa, from the Cameroons in the west, to north Tanganyika in the east. The range of the Chimpanzi is more considerable, for it is found as far east as Bunyoro (Uganda), in the south-west part of the Nile basin, as far south as Lake Mweru, and as far west as Liberia, Sierra Leone, and Senegambia.

Photo New York Zoological Society

A West African Chimpanzi

In the wilds these animals live in tribes

The Gorilla at Home

(From a painting by Sir H. H. Johnston)

This study has been made from the huge specimen of the South Cameroons Gorilla in the Museum at Munich, and from photographs and drawings by Sir H. H. Johnston of the Cameroons forests

Alpine Soldanellas that Flower in the Snow

Some Wonderful Plants

Plants that Flower in Snow—Feverish Plants—Floral Rafts—The Burning Bush

By S. LEONARD BASTIN

Author of "Wonders of Plant Life"

IN a general way there are few things which vegetation dislikes so much as intense cold. It is all the more remarkable, then, to discover a group of plants which actually produce their blossoms in the snow. On the slopes of the Alps the thick crust of snow does not melt all at once with the coming of the spring. Most of the plants underneath the white covering wait patiently until the snow is gone, but this is not the way of the little Soldanellas. These are pretty plants with delicate blue or purple bell-shaped flowers.

Long before the coating of snow has gone the flower stalks start to push their way up to the open. It seems incredible that these slender stems could possibly force their way upwards, and the story of how this is accomplished is one of the most marvellous in the world. In a general way it may be said that all growth on the part of plants is accompanied by the liberation of heat. This is much greater in some plants than in others, and in the case of the Soldanellas the degree is very considerable. Indeed, it has been said that the developing shoots of the Soldanellas bore their way up through the snow like so many hot awls. Providing the snow is not more than an inch or so in thickness, the flower

buds are not long in reaching the surface. We then have the very singular spectacle of a number of stalks bearing bell-shaped flowers apparently rising straight up from the field of snow. Anyone viewing the flowers for the first time would consider that the stems of the blossoms had just been stuck in the snow, seeing that there is no sign of their being connected with a plant. There is, however, an even more singular feature in the life of the Soldanella. On occasion these plants are covered with snow which may be quite thick. Yet even in this situation they will, in some mysterious way, feel the call of the spring, and with their flower stems start to bore up to the sunshine above. There is, of course, a limit to the growing power of all plants, and this point is often reached before the blossom of the Soldanella reaches the surface of the snow. It is then that a very wonderful thing happens, for the flowers actually open right under the snow. The constant giving out of heat from the opening buds thaws a small cavity in which the blooms expand, very much as if they were covered with a glass shade. The flowers attain to a perfect development in all ways, not only expanding their petals, but even producing their pollen, just as if they were in the sunshine above.

Ruskin, when travelling in Switzerland, was astonished beyond measure that such weak little plants could flower in such inclement surroundings. That the accomplishment is not a small one will be realised when it is remembered that the temperature of the snow crust is at freezing point, a degree of cold which usually checks active growth on the part of plants. It is generally believed that the energy necessary for the purpose is stored away in the thick evergreen foliage of the plant, which is formed the previous year. After the production of the blossoms this is usually found to be in a shrivelled condition, as if the plant were thoroughly exhausted after its great effort.

There are many singular plants in the world, but few more strange in their habits than the lichens. Some of the species of this singular group are little more than crusts of grey substance, clinging so closely to a rock or a tree-trunk that most people would not think of them as plants at all. Now lichens are, in their methods of reproduction, very similar to the fungi, seeing that they develop spores for the increase of their kind. These spores are

Plants that Flower under the Snow

The flowers of the Alpine Soldanella expand in a little cavity which they have thawed out by the heat given forth by the expanding buds

borne on special parts of the lichen, and in the case of some of the crust-like species a very singular effect is produced in this connection. One of the most remarkable is to be seen in the Writing Lichen. This plant, which may at times be found growing on smooth barked trees, is in itself nothing more than a film of grey. When it starts to produce its spores, a most curious change comes over the plant. The whole surface is rapidly covered with narrow black lines which take upon themselves the characteristics of Arabic letters. They are, of course, merely the bodies which are developed to bear the spores of the plant, but anyone seeing these for the first time would judge them to be part of a mysterious inscription. Early observers were much perplexed as to the meaning of the signs.

In some ways, perhaps, even more strange is the Map Lichen. In this case the spore-bearing bodies trace out lines which closely resemble the markings of countries on maps. The continents, oceans, and international frontiers of imaginary worlds, are delineated with marvellous clearness.

A Feverish Plant

Though the temperature of the air may be only 60° F., this arum will register a temperature of 110° F.

Human beings are not alone in being afflicted with high temperatures. At certain times in the life of the plant there are distinct signs of a very feverish condition, though with the vegetable this is not a sign of ill health. In the case of nearly all flowers there is probably a rise in temperature just before the buds expand. Some plants are much more remarkable in this respect than others, and a species of Arum which is found on the Mediterranean coast calls for special comment. The plant produces a good-sized flower, and means were taken to register the temperature in the interior of the bloom just after it had opened. This was found to be nearly 110° F., although at the time the temperature in the surrounding air was only 60° F. It was found that it was some little time before the air in the interior of the blossom cooled down. At the actual opening of the bloom it is stated that the flower, which has not a particularly agreeable scent when fully expanded, gave out a fragrance like wine. To get an idea of the actual amount of warmth given out by the arum, we must remember that the recorded temperature is above that of blood heat.

There seems to be no limit to the

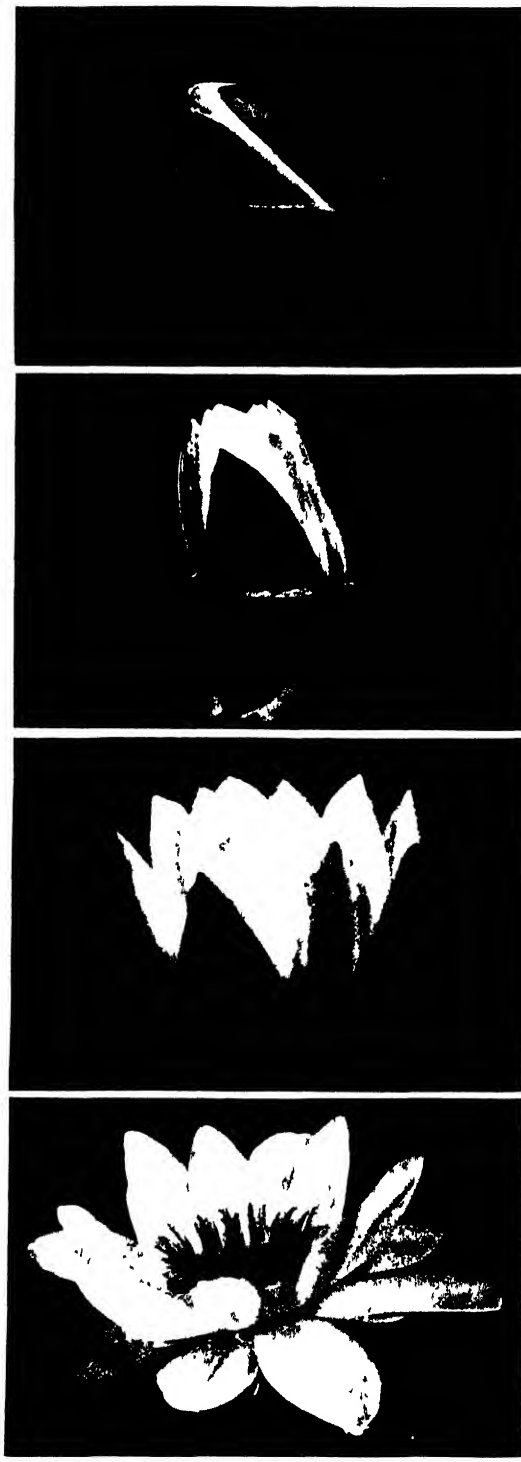
Some Wonderful Plants

wonderful things which Nature can do. Offhand it would appear to be a very difficult business to produce and display a large flower in the water, especially when it is remembered that moisture is harmful to the delicate pollen of blossoms. Yet the whole matter is carried out in the case of the Water-lily which, in its behaviour, is one of the most remarkable flowers in the world.

During the hours of darkness the great flower of the water-lily is tightly closed. All the beautiful white petals are drawn together, and the bud sinks well down in the water. The first rays of the rising sun bring about some wonderful changes in the water-lily. If watched closely, it is seen that the bud appears to increase in size. Finally there is a definite opening in the upper part of the blossom. The changes now come about with great rapidity.

The water-lily has a great many petals arranged in circular fashion round the centre of the flowers. These petals fall back in series, and as each bends outwards the water-lily rises higher and higher. Eventually the green sepals on the outside of the flower are forced backwards so that they spread out on the water in much the same way as a raft. Thus, by the time the water-lily is fully expanded, it is floating gaily on the surface. By an ingenious arrangement of the petals the possibility of any water entering the interior of the blossom is prevented, so that the pollen is quite safe from the moisture. As evening approaches the petals of the water-lily close once more, and the bud sinks below the surface again. Thus the pollen is shielded during the night from the damp mists which hang low over the water until the rays of the morning sun charm them away.

Certainly one of the most singular plants in the whole world is the Dittany. The species has for long been known as the Burning Bush on account of the extraordinary way in which it will, on



A Floral Raft

During the hours of darkness the great flower of the water-lily is tightly closed, and the bud sinks well down in the water. As day dawns the bud begins to open, and to rise supported on a raft formed by its sepals, so that the pollen is safe from moisture

A Volatile Oil

The dittany bush secretes a fragrant essential oil, which volatilises in warm weather and is given off as a highly inflammable vapour

occasion, behave. The Dittany is a neat bush with purple, or sometimes white, flowers, and it is found growing in dry localities in Eastern Europe and some parts of Asia. The whole of the plant secretes a fragrant, essential oil, and it is during a spell of very warm weather that an astonishing thing will happen. This oil volatilises and is given off to the atmosphere as a highly inflammable vapour. The amount of vapour which is emitted is particularly large near to the flower stalk, and if a lighted match is applied the gas catches fire and flames brightly. The flame is reddish in colour, and whilst it is burning there is a strange crackling sound to be heard. Moreover, the air all round the plant at this time is heavy with fragrance. Strangely enough, the lighting up of the Burning Bush does not seem to do any harm to the plant.

Treasures of the Humble

The Marvellous Gifts of the Lowly to the Wealth of the World

By ERNEST BLIGH

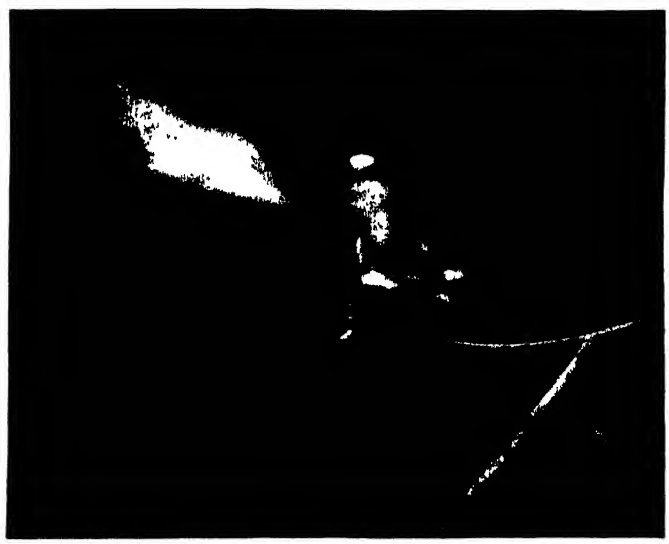
THERE is a certain romantic continuity to be traced in the great commercial enterprises of this world of ours; in some respects saddening, yet still romantic. The luxuries of life and the products of highest intrinsic value are to-day, as of old time, won for us by the very humblest. We derive our gold and silver and other so-called noble metals, our diamonds and pearls, and companion gear of price, very largely from the hands of untutored savages. Civilisation is as the queen bee, and the black men, the brown, the yellow, are as the neuter workers of the hive, fetching and carrying and feeding us, providing us with spices and condiments and medicaments, with precious ores, with gems for service and adornment. The British Empire relies for its daily life, as Solomon relied for the building of his temple, upon the aid of "heathen tribes without the law." Solomon had Hiram, King of Tyre, and his marvellous Phœnician navigators and traders to bring him gold and fine woods and precious stones from Asia and Africa and Europe; we have our savage kings and sheiks and sultans, and other of our semi-barbarous rulers to collect and garner for our ships and caravans and trains and pack animals the product of mine and river and forest. Solomon bartered agricultural produce for the wares he received from three continents; we sell cloth and calico, beads and copper wire, salt and weapons for the multitudinous fruits of the wilds, for food, for medicine,

for manufacturing processes, upon which we have come to rely.

It is strange at first sight, and yet in keeping with the due order of our affairs, that at the present time we should receive important supplies of the most precious of all metals from the labour of half-naked blacks in benighted Colombia. It is thence that we derive indispensable contributions to our stock of platinum, which, the anathematised waste of a former generation, is to-day worth in hard cash at least twice as much as gold.

London is built on a foundation of radium. Pitchblende, formerly used exclusively for the staining of glass, was thrown year after year on vast dumps, and used from time to time in making foundations, as to-day the refuse from furnaces is used. There is radium incalculable in those foundations, in the London underworld. And in the old days, when the properties and value of platinum were unknown, this incomparable metal was regarded as a curse by the men who mined in South America for gold. The descendants of the slaves who worked under the bygone conquistadores are still in the field, so to speak. All the labour of the tropical and sub-tropical American continent is done by the descendants of the negro slaves of a bygone generation; negroes whose ancestors, twenty-eight centuries ago, were toiling in the mines of Africa to enrich the temple of Solomon. But to-day they are repairing the extravagant methods of the sable miners who worked under the Spanish yoke and lash; they are winning treasure to-day from the waste heaps of a century ago.

Platinum in bulk is derived, in the main, from the Ural mountains, where an English company is at work with a capital of a million and a half sterling. The Colombian platinum is gained, as to great part of it, by means of plant and apparatus as primitive as that with which the native pearl-diver equips himself. The men dig and wash the soil along the watercourses near and in which the precious ore is found; women and girls, naked and unashamed, dive and dredge the rivers. A stone to make her sink, a little dish in which to scoop up the gravel from the river bed and bank, a calabash into which to drop her haul—that is her outfit for winning from its bed the most precious ore in the world. It is strange to think of these poor benighted people handling this indispensable ore. Platinum has taken its place as a primary essential in the chemical arts. The mere tyro on a motor-car, with accumulator ignition, knows how disastrous is his position if the platinum points of his coil fail him; the man with a fountain pen fears nothing so long as the platinum tip of his nib remains unimpaired; the uses of platinum wire are manifold; the genius of the electric lamp would have plied his arts in vain but for the same ore; and the latter-day alchemist in his dim, mysterious laboratory, who seeks the perfect



The Burning Bush

If a lighted match is applied this "gas" catches fire, flames brightly, and burns with a strange crackling sound

crucible, breathes a blessing on the metallurgical chemist who discovered the unique properties of this wonderful metal. And yet platinum, which ends in the hands of the savant, has its practicable beginning in the primitive scoop of a naked negro girl, who takes a prodigious gulp of air, dives down in the water, helped in her descent by a staggering boulder hitched to her sturdy loins, gropes with her little pannier in the mud, until her heart is nigh to bursting and her eyes leaping from their sockets, then thrusts herself up to the surface, tiptoes to the bank, and empties her mud into a calabash. And the result is platinum.

Dusky Belles

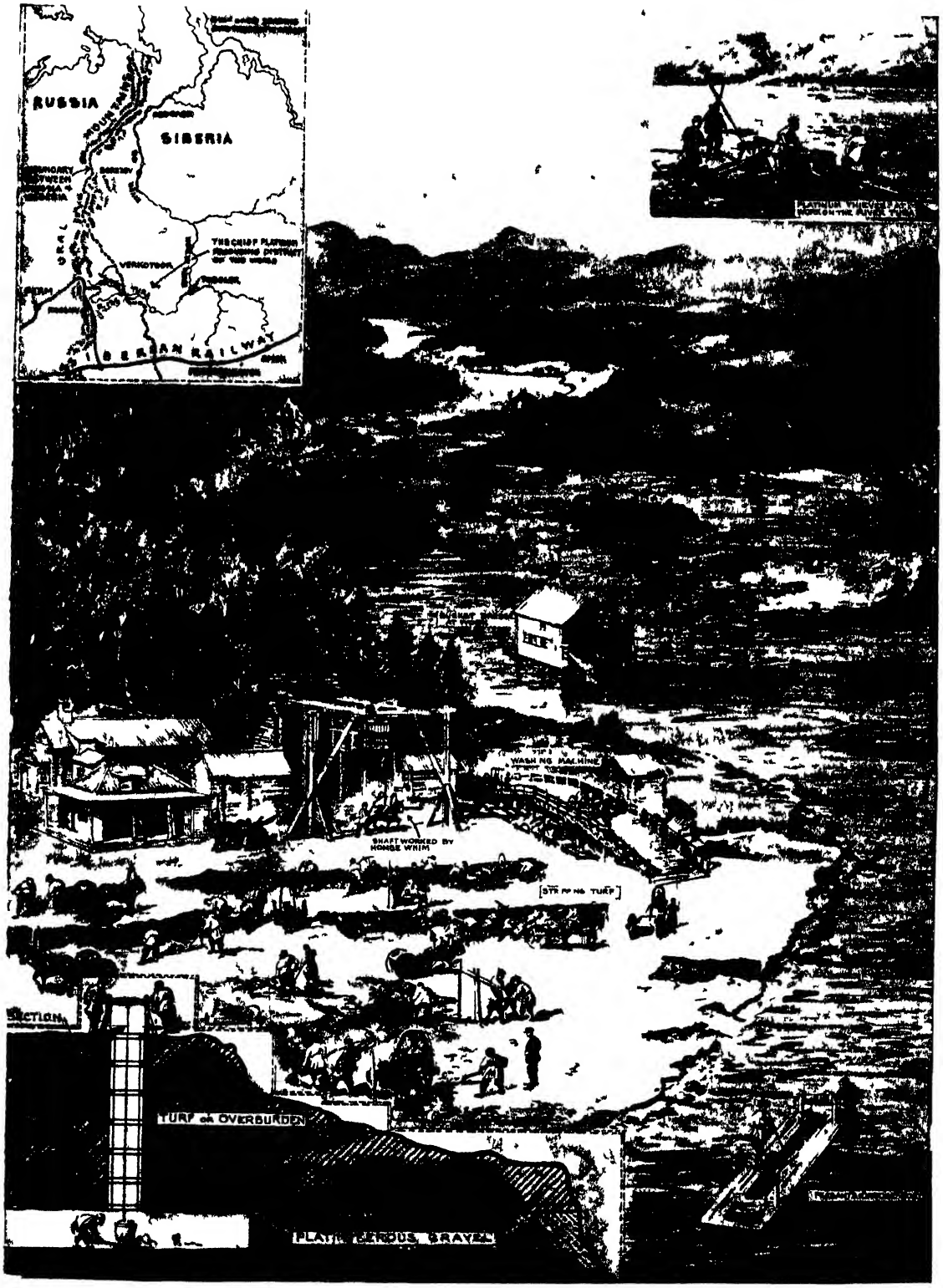
What a mystery it must all seem to these dusky belles, that they should be able to coin their panniers of metal-impregnated mud into calico of Futurist hues and glass beads of the same raging tints. She wins from the turgid mud the answer to the latest call of science for a new metal—ductile, hard, impervious to the action of the weather, defiant in the presence of heat and acid, inimitably soft and delicate when employed by the cunning hand of the photographer. The gracious features of the Queen of England are transmitted, in photographic reproduction, by the aid of a metal ripped from the oozy bed of a Colombian river by a strapping, unclad daughter of the wilds. The platinotype presentment of the King and Queen are indisputable links in our chain of Empire; those links are forged for us by this dusky Amazon, whose life in Colombia is ideal when it runs upon lines such as these:

"In the country a man can locate his house in the woods without fear of disturbance, erect it in one day from the wild growth surrounding him, and soon have a clearing made in which he can grow three crops of maize corn in a year. He must not plant more than his children can protect, however, from the wild parrots and animals, which like cultivated food. The plantain and banana produce within eight months from the seed, and thereafter, without much care, yield a continual harvest. The yam and yucca, a species of potato, yield very quickly, and are very hardy. Sugar-cane, once planted, is always present. With these products around him, and the river near to supply him with fish, the native is happy (with the exception of 30,000 untamed Indians, the natives are all the offspring of emancipated African slaves), depending for his meat upon the wild animals he can kill with his spears made from the lancewood of the country, or which he can entrap. . . . His only necessity for money is to provide for salt, rum, tobacco, clothes, and the machette, or long knife, which he uses for every purpose, from picking his teeth to cultivating his lands."

Since that time the native father has taken to digging and dredging for platinum on the river bank, while his daughter laves her lissom limbs down in the depths where the ore hides in the mud. The picture of this Alpha and Omega of one of the most urgent needs of science is striking, but not isolated. It was the rise in the price of spices which drew Columbus and his adventurers from the Old World to the New. Columbus sailed to the West in quest of the East, and died believing that America was the veritable China of Marco Polo. Spices, grown by the humblest of natives, called him to the West as it had drawn Da Gama to the East, round that continent which no man had circumnavigated since the bold emissaries of Necho, two thousand years before, had skimmed in terror, landing upon the coast to sow and harvest their corn. Thus they provisioned themselves for the prime adventure—the turning at the southern extremity of the land, whereafter they saw the sun, which previously had risen on their left hand, rise upon their right.

A Voyage of Terror

We still sail to the east by varying



Platinum Mining in the Northern Urals

(Drawn by Harold Oakley)

'The thickness of the platiniferous gravel does not exceed 4 feet," says the artist, "this is covered by turf, or overburden, to depths varying from 5 to 20 feet The pay-gravel, from open cuttings or shallow tunnels under the turf, is hauled in carts up an inclined platform—as shown in the drawing—over an upright cylindrical tank, about 7 or 8 feet in diameter, which has a floor of iron plate with $\frac{3}{4}$-inch holes in it—with a central revolving shaft with arms Here the gravel is washed, and the platinum is won"

routes to gain the spices which lured Columbus and Da Gama and Magellan from the sanctuary of Spanish and Portuguese harbours. We still find the spices in the hands of native husbandmen. Our pepper, ginger, cinnamon, cloves are all grown by native industry. Our luxuries are furnished by men and women whose wages would not support a self-esteeming London cat. The cup which cheers but not inebriates is filled at the instance of the native, who provides also the coffee and chocolate and cocoa which creep into competition. The King's state-coach and the plutocrat's motor-brougham both owe their mirror-like polish to the efforts of our fellow creatures of the wilds, who harvest the strange product of a tree provoked to a morbid secretion by the attacks of the lac insect, whose cousin, the cochineal, yields relatively generous guerdon to its native conservators in tempestuous, blood-stained Mexico. If the returns be quick, however, the profits are small per cochineal insect, for, before he collects a pound of *Coccus cacti*, the native must collect 72,000 picked insects.

Luxury and commerce are not alone dependent on the efforts of the native; the atmosphere of the most historic fanes in Christendom is perfumed with incense cultivated by the alien hands of unbelievers. Our frankincense and myrrh and the benzoin, which is an essential ingredient of incense, are all grown by the more or less uncivilised natives of parts of Africa, Arabia, and Indo-China. My lady in her sables derives her furs from the gory hands of the semi-savage native trapper; m'lud upon the bench takes his immaculate ermine for his judicial robes from the resources of the man of the backwoods whose path lies where the King's writ runs not. We owe every motor tyre, every rubber spring, without which railways would be impossible, every surgical instrument of vulcanite, every tobacco pouch, and telephone instrument, to the savage who either for the smallest pay, or as rent for the right to live, penetrates the dim steaming forest to collect the indigenous rubber, or cultivates the plantations in the East to which so many millions have recently gone.

Frankincense and Myrrh

And so one might continue through the whole gamut of the appurtenances of civilisation—the treasures of the humble are the supreme gift of lowly labour in wild ways and unfrequented paths of life to the powers which run creation. If the strike fever should ever animate the unmighty of the world, if the unorganised should organise, if the savage should take a holiday, if a thought of the utter dependence of his lords and masters upon himself should ever enter his wild and woolly head, the world would, so to speak, stand still. The strange, inarticulate men of the mysterious lands are the actual producers; we only transmute, fashion the raw material, make food from crops, which they have grown. We ennoble monarchs' crowns with diamonds for which they have mined and blasted, and with pearls for which they have dived amid sharks and devil-fishes, and into sea forests filled with perils dire.

If the Savage should Strike

Perhaps the relations between the civilised and the uncivilised peoples of the earth less resemble those between queen and worker bees than those which mark the economy of a colony of slave-making ants, which, having captured and subjugated and disciplined a community of less powerful ants, become eventually not the masters but the protégés of the slaves. If the Colombian girl should discard her boulder, and her contemporaries in the wilds of East, West, and South should emulate her example, civilisation would suddenly cease, for its members would themselves have to take to the wilds, there vainly to toil and to die, in the effort to make good the deficiency in the supply of the previously unconsidered treasures of the humble.

TRAINS THAT CROSS THE WAVES

By E. A. Bryant

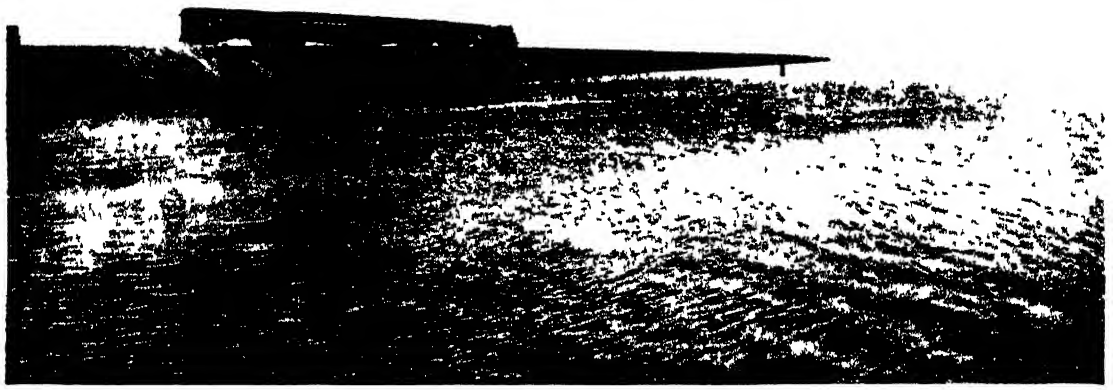


Photo Florida Photographic Concern, Florida

A Link in the Line from New York to Cuba

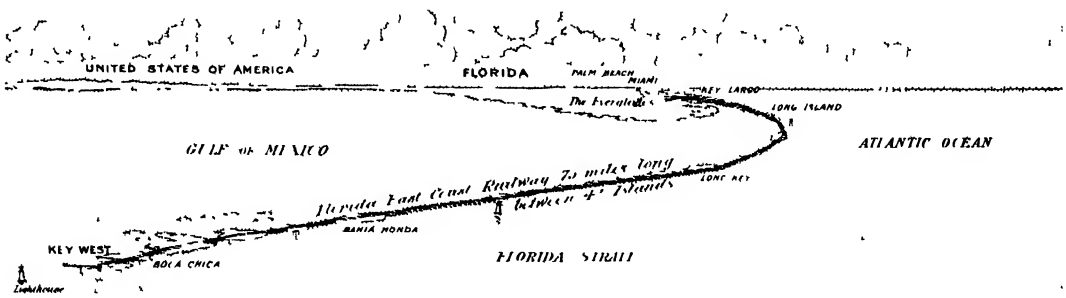
A Railway Out to Sea—Two Score Islands used as Stepping Stones

WHEN Mr. H. M. Flagler, an American oil king, died the other month, leaving a fortune of twelve millions sterling, reference was made to a railway which he had built to connect Miami with Key West. That railway, which is necessarily a mere name to most people in this country, represents one of the most romantic and spectacular engineering feats in the world. It embraces much more than the name of the railway implies. Key West is simply a coral island, sixty miles out in the sea, a dot of land seven miles long and from two to three in breadth. Why a railway there ?

As a fact, the system is a link in the line from New York to Cuba, and by the building of this railway a passenger covers the entire journey of some two thousand miles without once quitting his train. That train takes him, by stepping stones, to sea, until it reaches Key West, and there it runs aboard a steamer and gets itself transported for the remainder of the voyage, 91 miles due south, to Havana, the capital of Cuba. The line was built in the face of difficulties more to be expected in connection with navigation than with railway engineering. It involved the calculation by the engineers of the height of waves, the depth of seas, the force of winds, the nature and effect of currents, and all the phenomena proper to the calling of those that go down to the sea in ships. But it is a railway that results, a railway which braves the rude waves of the Atlantic on the one hand, and the swelling waters of the Gulf of Mexico on the other.

The sea line is really a marine extension of the Florida East Coast Railway. Beginning at Miami, on the east coast of Florida, it keeps the mainland for eight-and-twenty miles, then enters a swamp known as the Everglades, a tangle of mangroves, from

which, at the end of a further 17 miles, the line emerges at the coast and jumps out to sea. The feat is rendered possible by the existence of a great number of coral islands—the Florida Keys, as they are named. These coral islands extend from the east coast of Florida and curve south and west into the Gulf of Mexico in a bow, 200 miles in length. Key West is one of these keys, standing 60 miles south of Cape Sable, and rather more than 90 north of Havana. Now upwards of two score of these islets or keys are used as stepping stones for the line, which, from Miami on the mainland to Key West, but in the majority of instances the work was that of navigator as well as engineer, and it was necessary to construct embankments and viaducts in the aggregate many miles in extent. Where possible, the embankment has been employed; but where the water was too deep, embankments run out from island to island as far as practicable, and the remaining gap over deep water is closed by huge bridges and viaducts. There was a second, and that not a constructional difficulty, in the way of running an embankment from end to end of the line. For nearly six score miles this line runs out to sea, and so opposes a



Map of the Railway that Crosses the Waves

where the steamers take up the story and the trains, covers a distance of 154 miles.

Age after age, away back in the twilight of the world, insignificant labourers toiled to lay the foundation of the scheme which an oil king has crowned. The coral polyps built the Florida Keys, as the nummulites built the material for the Pyramids. They raised the islands from the bed of the ocean, creating them with their own calcareous skeletons. This chain of islands that flank the east coast of Florida is wholly composed of coral—a long succession of keys, parted one from another by various distances of open sea. Some of them are but a few yards apart, in other cases the distance is a matter of miles. Some are barely topped by the waves, others lie deeper. It was possible for men working dryshod to link island to island, formidable barrier, not only to the tides, but to navigation. It could not be permitted to have ocean-going craft, passing from the Atlantic to the Gulf or vice versa, butting into a colossal rampart thrown uninterruptedly across the fairway. So of the ten bridges that span the open sea, three are drawbridges, which open for craft as the Tower Bridge opens to give right of way up and down the Thames.

Seven years and four millions sterling went to the making of this unique line, and from the time that work was in full swing there were seldom fewer than 3,000 men engaged. The surveying and laying of the line constitute one of the most remarkable romances in engineering annals. The terrible Everglades are one vast swamp, infested with man-eating alligators; many of the larger islands are

no better. During the survey of these primeval wastes men were frequently lost for days together. In spite of the care exercised, a grave omission led to a serious postponement of the work. When the line had reached Key Largo, a deep lake, half a mile wide, and hiding a colossal accretion of peat was discovered where a firm base had been expected. And it took two huge dredgers fifteen months to remove this vegetable sponge before foundations could be laid.

Storms caused repeated interruptions. One drove a great mass of material and plant to sea; another wrecked one of the houseboats in which a large number of the workmen were lodged, with serious loss of life and damage to property. Considering the nature of the undertaking, however, the casualties were surprisingly small. The organisation was admirable. The negroes were lodged in tents on the islands; the white men on houseboats. Every crumb of food and drop of water had to be transported from the mainland, and it was all excellently done. It is a notable fact that this remarkable line, like the Panama Canal, was built entirely on total abstinence principles, the introduction of alcohol into the camps and boats being absolutely forbidden.

The engineering work teemed with difficulties. The maximum depth of sea to be crossed was 30 feet, the average 6½ feet, and the minimum—this applying to many miles of the course—only a few inches. At the outset the mangrove swamp mentioned had to be dredged and drained and laid with rock and sand to procure the necessary foundation. The plan was to employ two dredgers working on parallel lines, digging a channel for themselves, and casting up the excavated material to form an embankment in the centre. Where it was impossible for these and other dredgers to work their way afloat, they were hauled ashore, fitted with wheels, and run along a temporary track.

The sea works involved, of course, quite different operations. The plan adopted in the case of narrow gaps between islands was to build up from the sea-bed embankments of concrete reinforced with steel. Where viaducts were required the like materials were employed. Piles were driven for a foundation of from 4 feet to 10 feet. A cofferdam was then placed over the site of the viaduct pier, the water was pumped out, and a 3-feet floor of concrete laid. After this had dried the piles were cut off at the level, a wooden scaffolding for the piers erected, the steel framework was anchored, and the concrete placed in

Photo Florida Photographic Concern Ltd., Miami

Knight's Key Bridge

EN ROUTE FROM NEW YORK

(D)

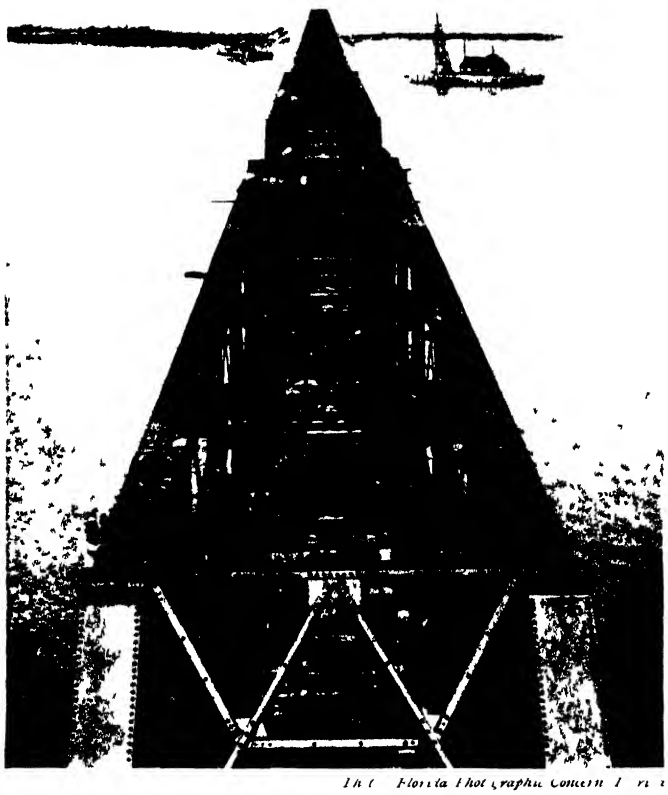
During the building of this line storms caused repeated interruptions One drove a great mass of material and loss of life and damage to property To-day the train runs from New York to Key West All told

CUBA—THE LINE SWEPT BY STORM

G. H. Davis)

to sea; another wrecked one of the houseboats, in which a large number of the workmen were lodged, with serious railway, after leaving the mainland, crosses 47 islands, and runs 111 miles of its 154 out in the open sea

position, in blocks of one cubic yard. Four weeks were allowed for drying, then the wooden scaffolding was taken away and floated off on barges, to be used for similar operations elsewhere.



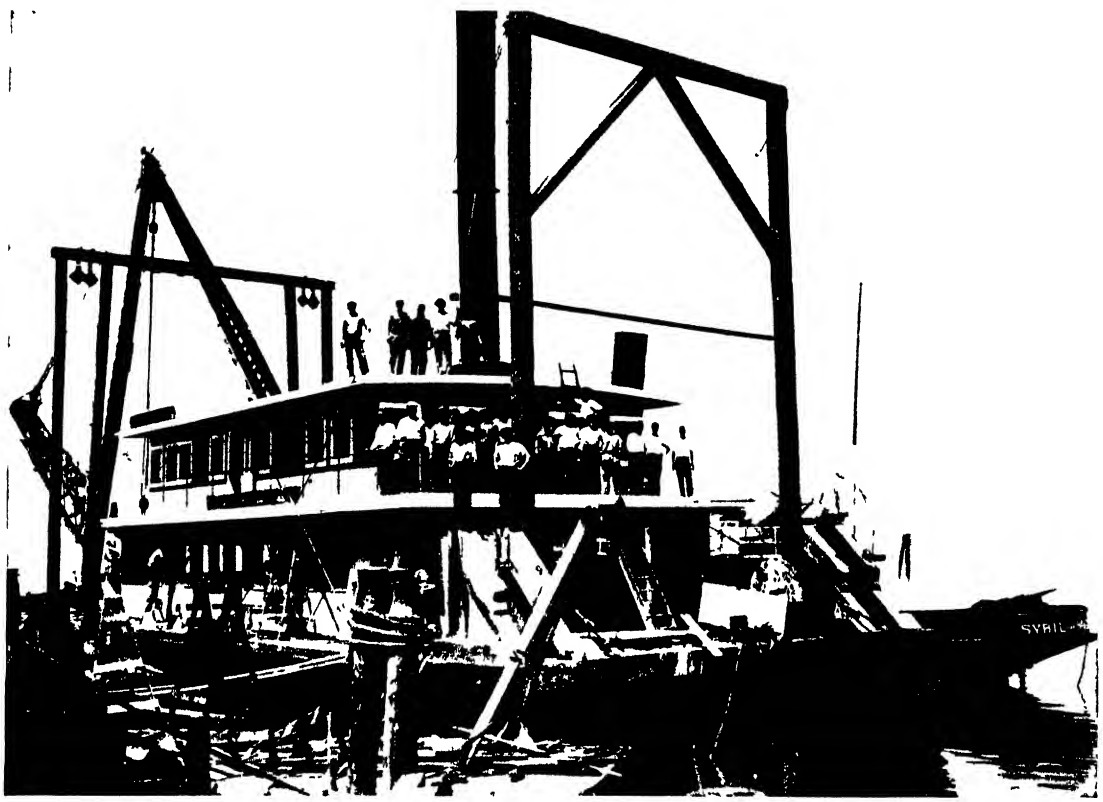
Bahia Honda Bridge—5,000 feet long

The longest viaduct, that from Long Key to Conch Key, stretches 10,500 feet; the second extends 7,300 feet across the channel of Knight's Key; a third crosses Missouri Key channel, a distance of 7,800 feet; while the fourth, spanning the channel at Bahia Honda Key, is just short of 5,000 feet in length. There are thus practically six miles of viaduct in the open sea. The longest consists of 186 spans, each of 50 feet. The piers for all the spans have bases at rock surface of 28 feet, tapering to 20½ feet at their highest point. The crown of the arches is 28 feet above water, but the track itself is 3 feet higher. A careful calculation shows that the highest anticipated wave does not menace the safety of the trains even though the rudest storm should buffet the viaducts.

Special plant had to be devised for the work of the line. Coal or wood could not be obtained for boilers of any but the sea-going craft, so internal combustion engines were used. The line may be said to have been built in the main from boats, and a strange assortment of craft they had. There were 3 tugs, 8 stern-wheel steamers, 30 gasolene launches, 14 house-boats for the white workmen, 8 boats fitted with cranes and concrete mixers, 3 floating pile-drivers, upwards of a hundred barges and lighters, and a complete floating machine shop.

Much of the material for ballasting was, of course, available on the spot, but a fleet of vessels was always at work transporting lumber, stone, steel, cement, and the like to the scene of operations. Under the circumstances it is not surprising to learn that the cost of making the viaducts averaged £100,000 per mile, and the land grading over the numerous islets upwards of £1,200 per mile. All told, the railway, after leaving the mainland, crosses

47 islands, and runs 111 miles of its 154 out in the open sea. It includes, in addition to 6 miles of viaduct, 80 miles of embankments across the islands, 28 along the mainland, and 40 miles of earthwork. A little town was created at Knight's Key when rail-head reached that point, 109 miles train runs from New York to the coast of Florida, out to sea across the stepping-stones and the great sea viaducts, to Key West, where it puffs its way on to the deck of a steamer equipped with rails, makes fast, and sails the remaining 91 miles south to Havana. The Florida Keys are



A Floating Workshop

The railway was built from boats such as this, and many workers were drowned owing to their breaking loose during severe storms

from Miami, and within two years of the inception of the scheme trains ran thither to be met by steamers which took off their cargo and passengers. But the next forty-odd miles required five years to complete. The time was not wasted, for in the interval an army of men reclaimed some nine score acres of land at Key West, and built extensive docks and wharves and covered piers in readiness for the heavy traffic.

The line was completed in January of 1912, and inaugurated with a modesty and reserve quite un-American. And to-day the no longer the abode solely of alligators and strange hermit men. The romance of engineering and enterprise has supplanted the romance of the two or three men, in those scores of dismal silences, who had lived there from time out of mind, voluntarily marooned, subsisting upon fish and the natural vegetation of the islands. The railway has come, the hermits are gone, and the alligator's bark is drowned by the scream of twentieth century iron horses on wheels, the first that ever went, under their own steam, to sea.

Photo L. Ullyett

A Group of Sea-Anemones

The Flower Gardens of the Sea

The Wonders of Marine Animal Life which we mistake for Plant Life

By N. F. WATSON

THE sea has its Eden, whose serpents have already been discussed in these pages. But it has a seeming flora as beautiful as any that terrestrial latter-day Edens afford. We feast the eye upon a sea-picture radiant with colour and beauty, delicacy and intricacy of outline, such as makes the tyrannous head gardener angry when his mistress asks for a similar picture in her own pet borders.

"Such colours can't go together, ma'am," he assures her ladyship, ignorant of the fact that Nature, the greatest and first of all landscape gardeners, is utterly against him.

But in respect of the sea-garden, he is right, though not in the way he thinks. Unless we can all follow the immortal Alice into Wonderland, or the realms beyond the Looking-Glass, we cannot have live animals as vegetable growths, any more than it may fall to our lot to have plants as live animals—in spite of the fact that a younger, though not necessarily lesser, Darwin assures us that plants see and think and have, as it were, "a brain, a cerebellum, too."

Our sea-garden is all alive; alive, not in the sense in which plants are alive, but as animals are alive. Alive, voracious, carnivorous are these features of the sea's beauty spots. Aristotle knew all about it, of course, but you would be exceeding successful if you convinced the average man about town that these beauties of the deeps have as much life and activity, of a sort, as the octopus, and pretty much the same sort of manners as that fearsome beast. Corals are animals, not insects—animals which raise bulwarks uncharted in the seas, to send stout ships shattered to the Port of No Return. And sea-anemones,

The Garden of the Sea

Almost as vivid in coloration as the flower like sea anemones 1 *Discosoma Kenti* 2 Giant *Discosoma Haddoni* (both expanded) 3 *Tealia crassicornis* and 4 *Cerianthus nobilis* are certain fish and crustaceans such as 5 *Amphiprion bicinctis* 6 *Amphiprion percula* and Giant prawn *Palaemon*

which form the sea-gardens, are animals in the same class. They are all polyps. The first-named is a little animal secreting coral; the second is a polyp which does not secrete coral. But each *is* an animal.

Your flower of ocean may be a perfect lady of her kind, or a humble member of the sterner sex; in communities you find both sexes intertwined in a sort of systematic confusion. Rarely you find the two sexes combined in one and the same individual. Let it be added that "rarely find" is written advisedly, for deep-sea anemones are myriad-fold more numerous than searchers.

Their forms and coloration and habitat are very variable, but to arrive at a clear conception of the absolute animalism, so to speak, of the anemone, let us take a swift glance at the structure of a generalised group of anemones. Every beauty not without savour has her sting; and the attribute is not denied the sea-anemone. In fact, it has an enormous number of stinging-cells. These cells are located in various parts of the body, but chiefly, of course, in the many tentacles, which, in miniature, are in effect as the tentacles of an abnormally equipped octopus. The octopus merely has his clinging, clammy tentacles furnished with loathsome sucker discs. The sea-anemone has multitudes of implements for the capture of prey, and doubtless for defence.

The tentacles are armed with a vast number of microscopic vesicles. Each of these vesicles is one of the so-called stinging-cells. Each contains an acrid fluid and a spirally coiled thread. When the animal comes in contact with its prey, not one, but thousands of these stinging-cells burst, and each ejects with considerable force the said filament. This filament bears a sharp point, and is often barbed, after the fashion of the vegetable villainies which pierce the

Denizens of the Sea-Gardens

The classes are: (1) *Rhizopoda*, (2) *Flagellæ*, (3) *Infusoria*, (4) *Sponges*, (5) *Hydræ*, (6) *Scyphozoa* (girdle-of-Venus), (7) *Echinoderms* (star-fish), (8) *Plathelminthidæ*, (9) *Myzostomidæ*, (10) *Nemathelminthidæ*. (11) *Trochozoa*, (12) *Chætognathes*, (13) *Arthropoda* (crabs), (14) *Hemidordæ*, (15) *Cordæ* (fish)

A Group of Jelly-fish and Sea-Anemones

(Drawn by A Fanfax Muckley)

1. *Pelagia noctiluca*
2. *Rhizostoma cuvieri*
3. *Aiptasia mutabilis*
4. *Cerianthus membranaceus*
5. *Anemonia contarini* (growing on Zostera)
6. *Palythoa axinella*

Flowers of the Sea

Photo A Ullyett

A Common Medusa

unsuspecting hand which innocently brushes over the golden crests of a certain famous rascal of the *Opuntia* cacti. The anemone's filament, like the cactus, strikes home and affords another famous example of Nature repeating herself. The filament here plays precisely the part of the cobra's fang. As the implement enters, a poisonous fluid, emerging from its core, enters the centre of the wound, exactly as serpent venom penetrates the flesh which the fang has bitten.

The poison benumbs, or even kills. At any rate, all the tentacles close tightly down upon the prey, and there is no escape. What is the prey, and how is it to be assimilated? One was tried, in an aquarium, with a halfpenny, swallowed it, and finding it less succulent than necessity demanded, rejected the coin as base. But shrimps, prawns, marine worms, youthful confiding crabs, snails, and fishes are among the common details of daily diet. There is a vulgar saying, applied to the greedy, that one's eyes may be bigger than one's stomach. The saying has no relevancy in anemonic circles. The anemone can swallow a creature much larger than itself—can and does. Let us take a trip, in horrid fancy, into its internal economy. The tentacles, or arms—the grasping apparatus—encircle an opening which is a sort of general receiving department as well as an ejector. It is an elastic tubular opening communicating with a large, muscular, and deeply grooved stomach. That stomach is one of the great natural marvels of the animal creation. In comparison with this organ, the stomach of the ostrich, which is supposed to receive with equal equanimity an umbrella or an onion, may be considered a mere symbol of dyspeptic delicacy. For the anemone of the seas absorbs not merely crustacea—shrimps, prawns, and the like—but actually large shellfish.

Photo A Ullyett

A Colony of Polyps

Generally speaking this masterpiece in stomachs abstracts the nutritive juices of the food received, then ejects the innutritious residue from the same passage by which it entered. But it can do better than that. That bald statement does not represent justice to this discriminating and powerful organ. It can

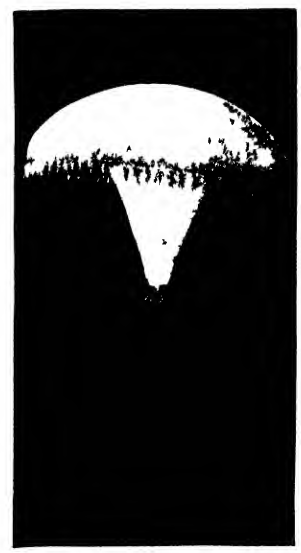


Photo A Ullyett

The Umbrella

receive, drain, and eject the shellfish; it can accommodate and assimilate a fish larger than the entire anemone. It can reduce shrimp or prawn to a residual product hardly worth considering. A curious thing is that, although the anemone does habitually feed upon these crustacea, you invariably find, in the proximity of certain species, a deliciously inviting-looking prawn scarcely to be discovered elsewhere. It cannot be that the anemone follows the prawn; it must be that the prawn goes to its potential devourer. That, however, by the way. It may be a product of that system of animal partnerships called commensalism, to which we shall presently have to return.

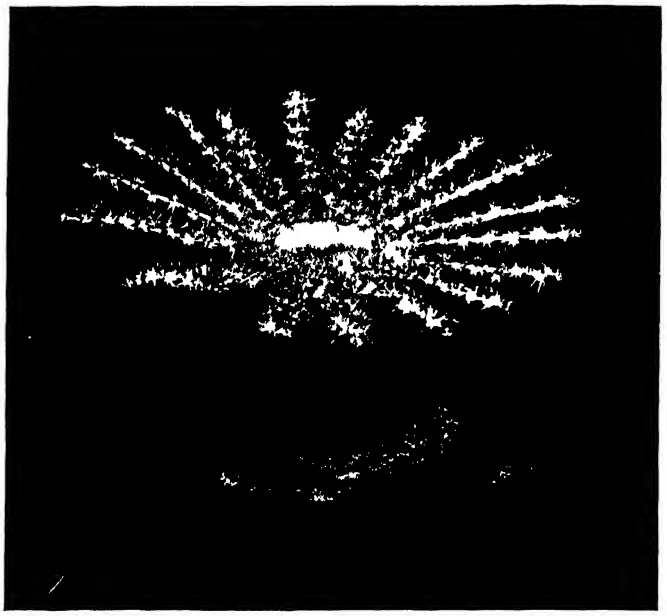
Photo A. Ullyett

A Rare and Beautiful Medusa

The anemone, as we have seen, may, in a not very delicate but expressive Americanism, "bite off more than it can chew." It may engulf prey too large and angular or corrugated to make possible return by the way in which it entered. What is then to happen? Is the sea-anemone to die, as a python has been known to die after swallowing a goat with horns too large for even an efficient constrictor to master? Not so the anemone. It achieves a feat so marvellous in lowly life that an actual example must be cited. Here was a moderate sized specimen of the *Actinia crassicornis* species, which had swallowed a live scallop-valve of the size of a saucer. Scallop shells, as we all remember, are in certain instances so large as to serve as baptismal fonts. The present one, though not so wide as a font nor as deep as a font, served. It was so much larger than its receptacle that it absolutely closed the passage between the stomach and mouth of the anemone. The latter was, therefore, literally partitioned in two halves, with the shell rigidly fixed as the dividing wall.

The anemone was in the same predicament as the horse which has swallowed a poison. The horse cannot vomit, and in such circumstances must die. The anemone was in the same difficulty, but it had a remedy. Instead of meekly yielding to the force of circumstances, it set to work neatly to repair the ravages of the too ample and indigestible meal. The passage between mouth and stomach, be it remembered, was absolutely sealed, and death from starvation dire seemed at hand. But under the observation of a good naturalist the anemone was seen to master the untoward accident. A new mouth, armed with two rows of tentacles with an adequate endowment of stinging-cells, was formed on what had been the basal side of the body; the master self-surgeon had formed a new channel by way of which food could reach the under side of the stomach, access to which by the ordinary channel was barred by the unhappy cousin of church fonts. Nor is that the only wonder in the life story of this sea animal, which simulates the form of a posey new plucked from the dewy garden.

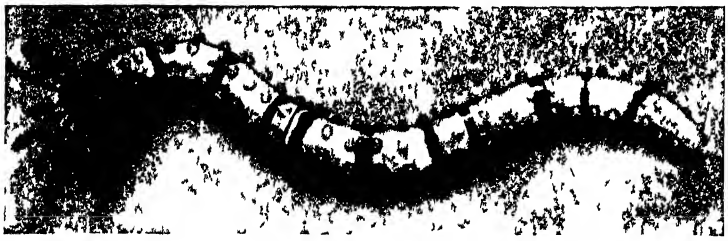
Sea-anemones may leave the parent body in swarms as eggs, or, in some cases, hatch before making their escape. After a certain amount of freedom—a sort of equivalent of our own old-time grand tour, or the modern German Wander-year—the stripling seeks a local habitation, if not a name. It attaches itself to a rock, or pebble, or to a crab, or is clutched to the arms of the latter; and thinks upon domestic and parental responsibilities. Once settled, the sea-anemone is, as a rule, a tenant for life, except in so far as the vicissitudes of tide, current, and storm may affect its plan of life. But sometimes it does desire change of quarters. Up to this point it has been



Photos A. Ullyett

Beautiful "Flowers" of the Sea

6. A Living Cluster of Grapes
7. A Sea-anemone
8. A Portuguese Man-of-War
10. A Sea-fairy from Nice
9. A Colony of Living Creatures—the Sea-fern



A Sea Slug

anchored by a fleshy stump to the chosen foundation. But when the time for removal comes the little animal, as it cannot take up its bed and walk, takes up itself. It may move by a sliding, slithering motion along the slippery surface of the rock, or it may even achieve a sort of semi-somersault, and flaunt it merrily, with acrobatic gait, upside down, upon its vertical tentacles. But such removals are generally attended by a more or less serious disintegration of the body of the little animal. It leaves behind it fragments of its foot-stump, firmly adhering to the rock to which it had been anchored. Mere unimaginative householders declare that three removals are worse than a fire; but in anemonedom the case is altered. The more the removals, the more the anemones, for from each fragment of anemone left upon the rock, an entirely new sea-anemone grows up, while the parent body renews its own structure without publicly advertised inconvenience. In fact the creature thrives upon hardship.

Perhaps it should, in its character of supposed vegetal growth, bear partition and sub-division. Cut an anemone in halves and those halves become two anemones, whether the cut be made perpendicularly or across the middle. Slice off the tentacles and new ones bourgeon forth. Their powers of resistance are indeed as high as those of some of the bacteria. They may be immersed in water hot enough to blister their skins, then exposed to a temperature no higher than freezing point, they may be kept without food for a twelvemonth, and yet recover; they may be safely submitted to the test of the exhausted chamber of the air-pump and yet remain living animals. One thing they cannot stand. Just as surely as any and every amphibian perishes in salt water, so in fresh water does the anemone yield up its oft-menaced life.

Our British trout may have been tickled by a discussion in the *Times* as to whether they are colour-blind; the same question, if we could speak the language of anemones, would probably arouse derision among the *Actinia*. Perhaps, after all, their marvellous colourings, their fiery-red and apple-green, their yellow and white, their rich browns and greens, their rainbow-tinted hides and tentacles, which give to tropical waters their suggestion of gardens of unmatched beauty created for Neptune and the mermaids, or as solace for Matthew Arnold's neglected merman—perhaps, after all, the brilliant coloration may have been less the result of sexual preferences than adaptation to environment. Miss Anemone may not have been influenced in her choice of a lover by his raiment, matching the coat of many colours, so much as by proximity of a possible mate arrayed in garb best suited to the neighbourhood.

But the crab makes no mistake when

Photo A Ullyett

A Sea Pen, a Colony of Living Creatures

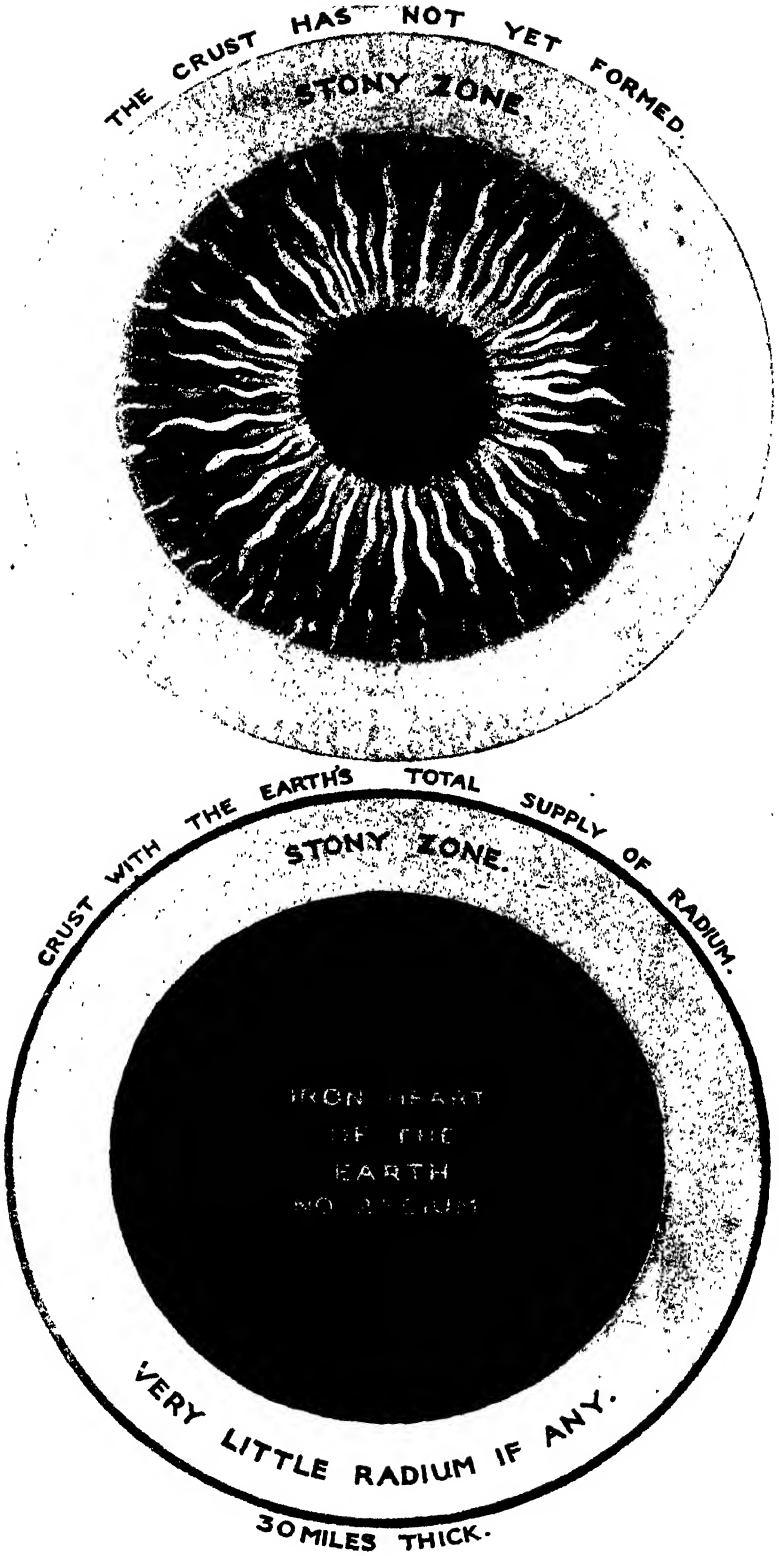
choosing a passenger. He sticks an anemone, or invites it to mount, either upon his back or upon his claws, and away they go together, life partners very often. When the crab moults his shell he is mightily anxious to take with him the passenger who has ridden upon the shell newly cast, and if the odds be against him, and he cannot get that one, his heart is heavy within him until he secures another partner of the same species and hue. The anemone is mask and decoy for him; the travelling crab is a perambulating larder to the anemone, in that it carries the hungry polyp to rich supplies of food

There is, then, no doubt as to the true animal character of the sea-anemone. The Greeks had a truer conception of the nature of the animal when they gave it its name, *aktinos*; our "anemone" simply shows our ancient ignorance of the character of the creature, for our title for the tiny lovely beast is derived from a Greek word signifying a wind flower easily stripped of its petals by the breeze. Our real anemone is, of course, that fragile beauty of the woods. Those of the sea, which are regarded as flowers, are the true animals which compose the fancied gardens of old ocean.

Photo by permission of the Queensland Government

A Giant Anemone (*Discosoma*)

This photo shows the anemone only two-thirds its natural size



Ideal Sections Through the Earth

(Drawn by John Gauld)

Illustrating a probable mode of evolution of its internal structure. The upper diagram indicates tongues of stony material separating from the earth's matallic core and carrying outwards the radium which at a later, more mature period (lower diagram) becomes still more concentrated in the outer crust

The Heat of the Earth

Is our Planet Growing Hotter?—How the Discovery of Radium has Revolutionised Scientific Theory regarding the Earth's Heat

By ARTHUR HOLMES, F.G.S., A.R.C.S.
Author of "The Age of the Earth"

IS the earth growing hotter? Will our planet one day be explosively scattered through space by the excessive heating of its imprisoned interior? These are the questions, so sinister in their catastrophic suggestions, and so intimately concerned with the destiny of our globe, which we must here attempt to answer.

The fact that the earth is continually *losing* heat—paradoxical though it be in the face of our introduction—admits of no doubt, for, as the earth's crust is penetrated by tunnels and mines, a steady increase of temperature with depth is always encountered. On the average, the temperature rises one degree centigrade in every 100 feet, and just as water will flow down a surface which drops 1 foot in every 100 feet, so heat flows down this temperature slope and escapes into outer space.

A spectacular, and therefore more convincing, proof of the escape of heat is provided by every volcanic eruption. The fumaroles and hot springs which accompany, and survive the last stages of, volcanic activity, tell the same story. It should be remarked, however, that all the heat which bursts from the fiery throats of the earth's volcanic safety-valves in the course of a year, scarcely amounts to one-tenth of that which passes silently from beneath our feet.

This evidence would seem to prove conclusively that the interior of the earth must be very hot, and that in the past the whole earth must have been much hotter than it is to-day. And until ten years ago it was accepted without controversy that such was the case, and that the earth, starting as a molten globe, had gradually cooled down by the radiation of its internal store of heat into the infinite coldness of outer space. So well founded was this belief that Kelvin, in one of his most important investigations, calculated that between twenty and forty million years had elapsed since the earth's surface first became *terra firma*.

Radioactivity, however, had yet to be discovered. With its unanticipated appearance on the horizon of the scientific sky, came the suspicion that Kelvin's treatment of the problem was fallacious and misleading, though, indeed, unwittingly so. The geologists learnt with gratitude that they need no longer be embarrassed by his formidable time limits. Vast stores of energy, which previously had been altogether unsuspected, were revealed for the first time, and for a while the geologists thought they had in their possession a blank cheque on the bank of time, which could be filled in as they pleased. Kelvin had regarded the earth merely as a spendthrift, living carelessly on her accumulated capital of cosmic heat. He never dreamt that a powerful source of income would be found in the inner recesses of the atom.

In 1903 came the announcement from the Curies' laboratory in Paris that radium is constantly giving out energy in the form of heat, a sufficiently startling assertion to awaken the keenest interest throughout the scientific world. All the radioactive elements were at once examined from this

new point of view, and the amount of heat given out by the families of which uranium and thorium are the parents, is now well known. Every atom is considered to be a tiny universe made up of a whirling assemblage of still more minute particles, and intensely charged with energy. The radioactivity of an atom consists in this, that its nucleus explosively breaks up from time to time, setting free some of the previously locked-up energy, and thus giving out a regular supply of heat.

Photo Kerry & Co., Sydney

Beel's Bore

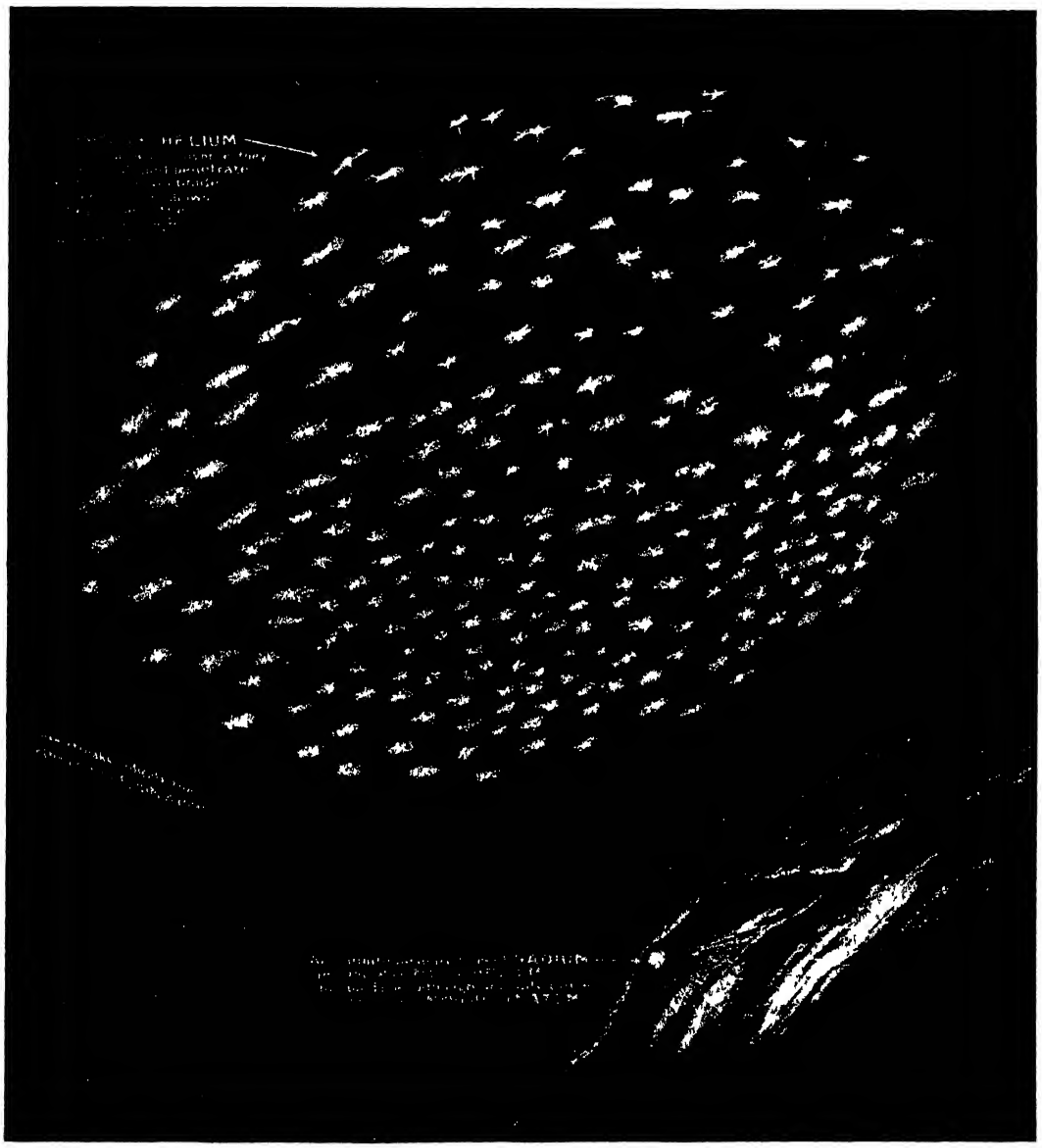
From this Australian bore, 1,706 feet in depth, 5½ million gallons of water with a temperature of 109° F. flow daily. The question of the source of the water's heat has aroused much controversy

Now the radioactive elements are found in all waters and gases of natural origin, and in all rocks and soils. Certainly, the proportion is exceedingly small, and apparently quite insignificant. The radium in ordinary rocks, for example, rarely amounts to more than one ounce in ten million tons of rock. But this quantity, representing the whole uranium family, gives out every year sixty million calories of heat, an amount equivalent to the burning of twenty pounds of coal. And here arises a most astonishing and embarrassing fact. When all the heat radiated by the earth is carefully computed, it is found that a distribution of radium averaging only one ounce in a thousand million tons would more than supply all the heat which escapes. That is to say, if radium is distributed throughout the earth to the same extent as in the surface rocks, then the earth's income of heat must be more than a hundred times greater than the amount lost. To make matters worse, the thorium family, though less energetic in its production of heat, is much more abundant in the rocks, and is collectively responsible for just as much heat as radium and its associates. Altogether we must face the possibility that our globe is accumulating heat two hundred and fifty times faster than it can expend it.

While for millions of years this dangerous accumulation might not result in any surface disturbance, yet, ultimately, there could be only one result. An era of widespread vulcanism of unsurpassed violence would be inaugurated; the earth would become furiously ablaze with its pent-up energies, and, in the opinion of some scientists, it might even be burst into frag-

ments and dispersed as a nebulous cloud —the explosion of a world brought about by the explosion of an atom.

elapsed time enough for its consummation again and again. Indeed, by now, the whole earth could have been raised to the appal-



Drawn by G F. Morrell

The Flight of the Atoms

With the aid of a spinthariscope, a small instrument fitted with a powerful magnifying lens and containing a disc covered with a film of zinc sulphide, it is possible actually to detect the charged helium atoms, or α-particles, liberated from a minute particle of radium placed between the disc and the lens

We may, however, dispel this gloomy picture of catastrophe, and take comfort in the gratifying thought that if such had been the destiny of the earth, there has already

ling temperature of 60,000° centigrade. Our very existence tells at once against such a grim possibility. Moreover, the earth has folded its surface into the gigantic

wrinkles which build up most of our high mountain ranges. This implies that the earth must have contracted, just as the wrinkled skin of an apple tells us that it has dried and shrunk. In turn, contraction implies cooling, and thus with many an eloquent fold and thrust in the crumpled up rocks of the great mountain systems, the earth herself refutes our suggestion that she may be growing hotter.

There are only two ways of overcoming this remarkable discrepancy. Either the radium in the interior of the earth is incapable of giving out heat, or there can be no radium there at all. The first alternative may at once be dismissed, for there are no means known to us whereby the heat output of radium can be either accelerated or retarded. We are utterly powerless to control this spontaneous and unceasing generation of heat. Let us then turn, with interest renewed, to the second possibility—that all the radium of the earth is concentrated in its outer crust.

Two Alternatives

This view receives strong support from our conception of the interior of the earth. At twenty or thirty miles below the surface lies a deep zone of very heavy rock, and still deeper lies the great iron heart of our planet. Originally, all these materials, light rocks, heavy rocks, and iron, were intermingled in the same way as are the meteorites which fall from day to day. Of the latter, which represent to us the fragmental remains of a shattered world, half are of iron, and half of heavy rock.

The young and still growing earth probably began to divide into two zones at a very early stage in its history, for as the temperature and pressure increased, all the stony material would be squeezed out of the metallic core, just as slag is squeezed out of wrought iron by the steam hammer. The radium and its associates would accompany the lighter stony material, leaving the heavy interior with scarcely a trace of their former presence. This daring conception is justified by the fact that iron meteorites contain no radium whatever, and also because terrestrial native iron contains less than any other mineral.

So far, then, the earth had divided into two zones, with all its lighter rocks, and all its store of radium concentrated in the outer one. But the process did not stop here. Volcanic action still went on, aroused by the continued squeezing outwards of the lighter materials as they became hot enough to flow, and so at last the earth's crust, consisting of the lightest rocks of the whole earth, was evolved. It is a curious fact that the radioactive elements—the heaviest known substances—are found most abundantly in the lightest rocks. Indeed, on an average, it is safe to say that the heavier the rock, the less will be its content of radium. Consequently, we must assume that the surface rocks received their enrichment in radium at the expense of the underlying belt of heavy rock, which was thus for ever bereft of its capacity for generating heat.

Stony meteorites are made up of minerals which are probably very similar to those of the earth's intermediate zone, and if the latter had originally contained as much radium as do certain meteorites, the total quantity would just have sufficed to supply the outer crust with the quantities we find in it. Finally, and most important of all, if our interpretation of the evolution of the earth's crust be correct, the amount of heat self-generated in the earth must be just balanced by the amount which escapes into space. We need not fear that our earth will be burst asunder by excess of heat; rather will it perish of old age, when all shall be "a sleep and a forgetting."

Earth's Old Age

Photo S. I. Jacobson, Trinidad

The Pitch Lake at La Brea. Observe the Watercourse

A Lake which Contains 3,000,000 tons of Asphalt —A Natural Marvel which Enriches a Government

AT La Brea, in the island of Trinidad, there is a lake of pitch, a natural wonder which goes a substantial distance towards meeting the expenses of the Government, which derives £10,000 a year in royalties from the company working the concession. The deposit is probably due to the semi-solidification of natural petroleum which has welled up from deep oil-producing strata.

In spite of its great interest, the first impression of a visitor to the lake is apt to be depressing. Certainly, after one has toiled on a tiresome mule, or in a body-shaking cart, from the pier at Brighton—a port on the coast of the island, where there is a long vista of insect-proof houses built for the white men in charge of the pitch industry—the sight that meets the eye is disappointing.

This feeling is perhaps caused, to some extent, by the irritation the fine dust creates, as the wind sweeps over the surface of the road leading up from the sea to the lake. This road is formed on a bed of asphalt, which, like a glacier, is always slowly moving. At its highest point the winding road rises to nearly 130 feet above the level of the sea, towards which it is steadily progressing. When one has removed the dust from one's eyes, however, the sight of the vast expanse of dark-brown asphalt—not hard as we know it in this country, but of the consistency of putty—is one well calculated to arouse the wonderment of the most hardened sightseer.

A belt of luxuriant tropical trees and shrubs encircle the lake, their varied greens presenting a striking contrast to the drab acreage of pitch. Brightly-coloured humming-birds, flashing in and out of the foliage, and myriads of tropical butterflies vie in splendour with the flora at La Brea.

The lake is not level, for, in places, little mounds of pitch rise from the surface. These hummocks are surrounded by many

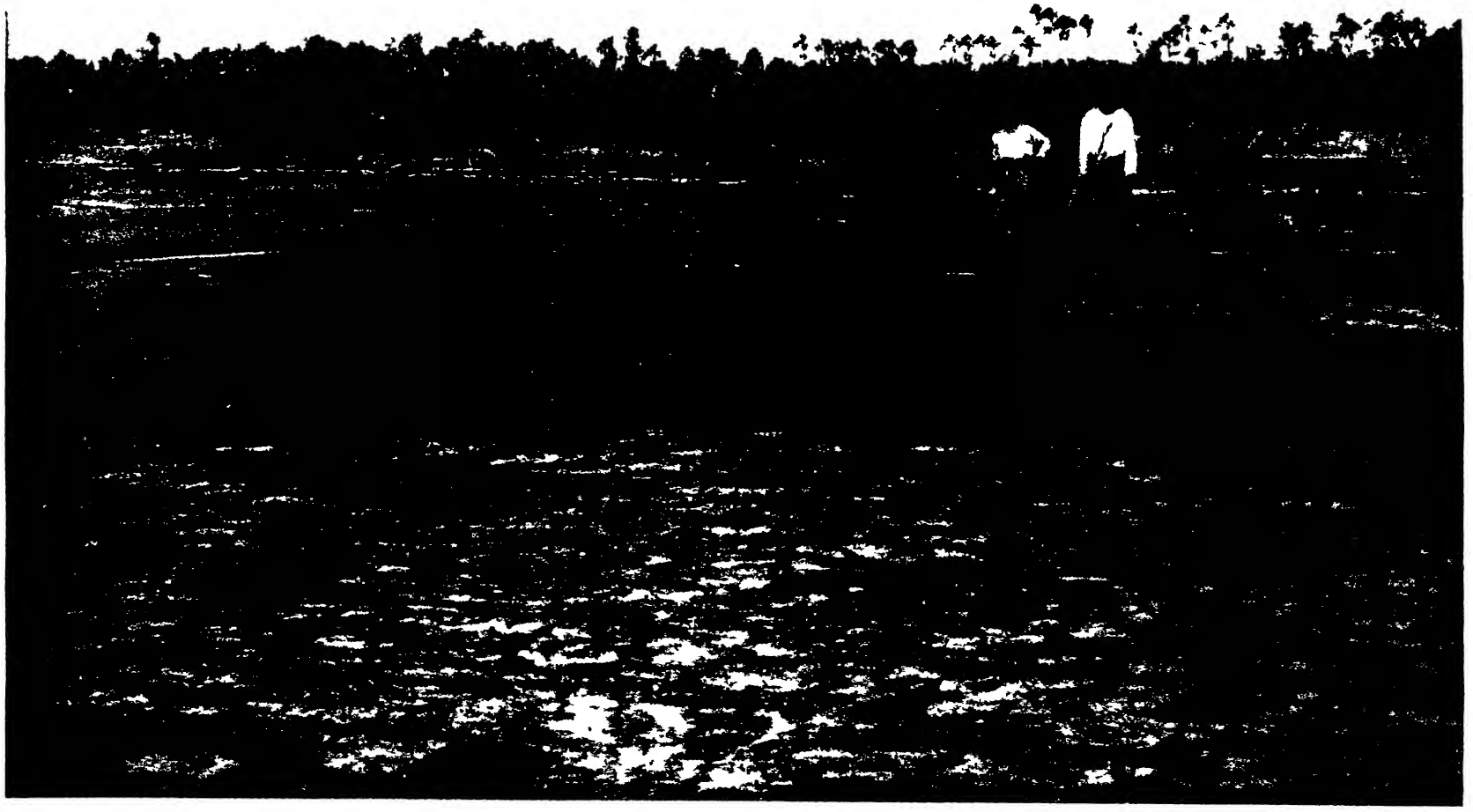


Photo S. F. Jacobson, Trinidad

Walking on the Asphalt Lake

A belt of luxuriant tropical trees and shrubs encircle the lake their varied greens presenting a striking contrast to the drab acreage of pitch. Little watercourses can be seen stretching like arteries and veins of gleaming silver across the sombre face of the lake

little streams of rain water, clear as crystal and tasting of sulphur and pitch. It is a pretty sight, under the sun's bright rays, to see these pellucid watercourses stretching like arteries and veins of gleaming silver across the sombre face of the lake. They can be seen flowing between the countless hummocks on every side. In apples, the latter fruit being of exceptional excellence.

A tramway conveying buckets, laid on a quaint palm-branch road, runs to where the men toil in the heat of the West Indian sun, shovelling and picking out the asphalt for export from the island. As soon as the buckets are filled they are dispatched by

Harvesting the "Crop" of Pitch

places, in fact wherever there is a sufficiency of soil, small trees and bushes grow from the pitchy earth, and scattered clumps of vegetation creep out over the Tartarean lake and flourish remarkably.

Here and there clumps of dense shrubs and plants grow on the lake's surface in "islands," as they are termed by the pitch diggers. On these the agriculturalist has established himself. Small plantations of cassava—a plant yielding a starchy root indigenous to South America, and a valuable source of food supply to the West Indies since the earliest days of colonisation—are grown, together with plantains and pine-

an overhead cable. This endless cable conveys the island's natural wealth, for which all ports in the world are open, to the vessels waiting at the wharf.

One can walk in perfect safety upon the lake's surface, though some accounts have described it as a dangerous proceeding to stand still for long on the soft pitch. It is only in certain places, where the asphalt bubbles in the heat of the sun, and the gas cavities give off sulphuretted hydrogen, that one experiences a feeling of insecurity under foot.

At the worst one would not, in any case, sink more than a few inches.

Pitch Lake of Trinidad

A curious feature of the pitch lake is the fact that the dirty-looking substance is very clean to work among.

It would seem to be practically identical with the pitch one sees in huge barrels where a road is being mended, which stains indelibly, yet it leaves no mark or soil, either upon the hands or clothes of the visitor.

Some years ago I visited the lake, garbed in the purest of white ducks, and naturally expected that by the time I returned to my ship they would have suffered severely. As a matter of fact, to my considerable astonishment, nothing of the kind occurred. My garments did not suffer in the least degree, although I explored the lake thoroughly.

On inquiry afterwards, I ascertained that this is the usual experience. At La Brea the old proverb does not hold good, for it is possible there to touch pitch without being defiled.

The total area of bituminous substance at Pitch Lake is just under 100 acres. Its exact depth is unknown. Some striking figures are given by Sir Boverton Redwood, which demonstrate the great wealth of the lake at La Brea. For each foot of depth he estimated that there are 158,400 tons of asphalt. Supposing the average depth is taken at 20 feet this brings the total up to 3,168,000 tons!

The annual output of pitch from La Brea amounts to some 130,000 tons.

The Beach at La Brea, Trinidad

Brightly-coloured humming-birds, flashing in and out of the foliage, and myriads of tropical butterflies vie in splendour with the flora at La Brea

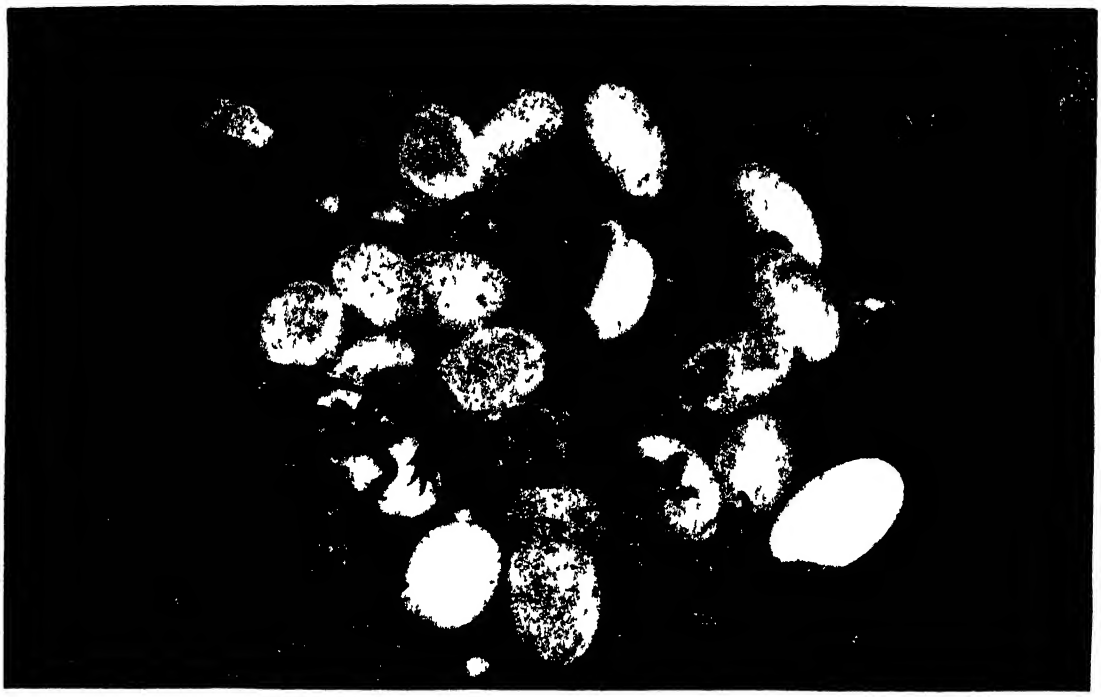


Photo. Illustrated Photographic Concern

In Addition to Lizards (shown here) many other Reptiles Lay Eggs

Some Curious Eggs and their Owners

How Lizards, Turtles, Frogs, Snakes, Insects and Snails all lay Eggs

By W. S. BERRIDGE, F.Z.S.

ALTHOUGH we are all aware that birds lay eggs, yet it is not so generally known that certain mammals and reptiles also produce their young in a similar manner.

The former class are represented by the Echidnas and the Platypus or Duckbill; but as further reference will be made in a later article to the echidna, we will confine our remarks to the duckbill, in this respect.

As its name suggests, this animal is possessed of a curious flattened beak, although in the young this feature is, at first, little developed. All the feet are webbed, a fact which is more noticeable in connection with the front pair, and in which the webbing extends beyond the nails, and forms a kind of pad under the foot proper. Such an arrangement is naturally a great aid to them when swimming, but as they are also burrowing animals, and excavate long tunnels in the banks of streams by the use of the claws on their front feet, the same feature appears, at first sight, as a hindrance for such work, and indeed such would be the case were they not able to fold back these webs at will, and thus leave the claws free for action. The burrows, which at times attain to a length of fifty feet, end in a chamber, wherein the female lays her two eggs, which are enclosed in a soft, white shell three-quarters of an inch in length.

Many reptiles lay eggs, including the crocodiles, alligators, certain species of snakes and lizards, frogs and toads.

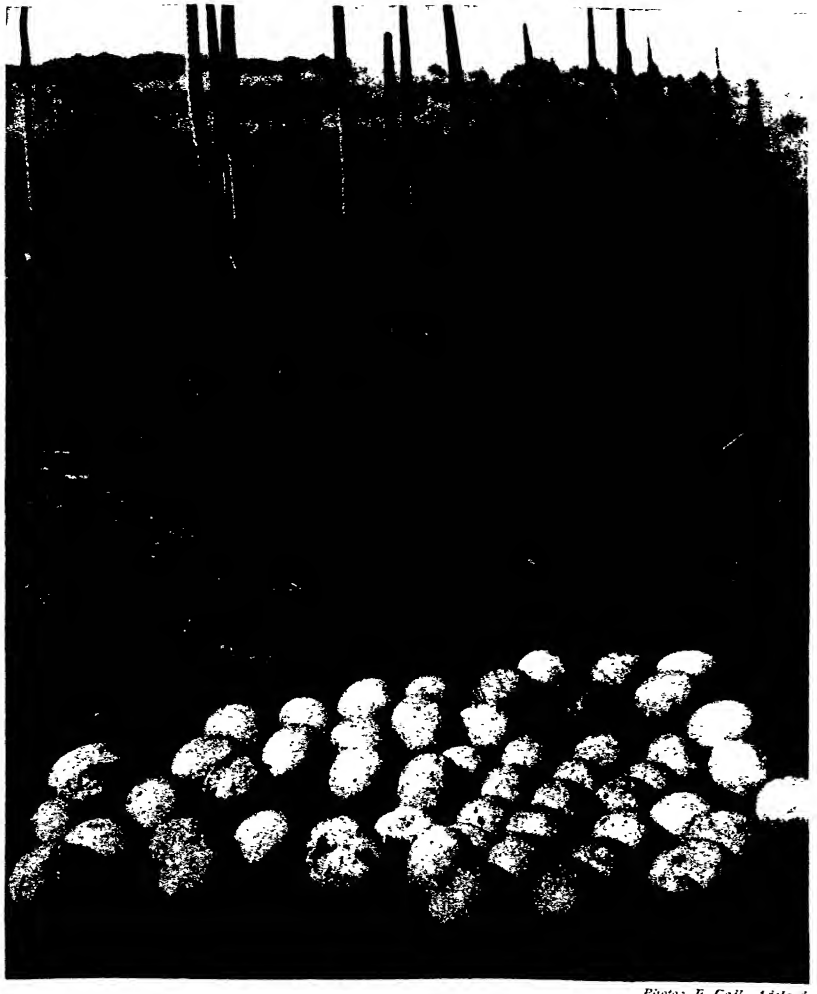


Photo: E. Gall, Adelaide

The Nest of an Ostrich

This photo was taken on an Australian ostrich farm. Note the grass-trees in the background. The ostrich is a polygamous creature, and three or four hens will lay their eggs in one nest, which they incubate by turns

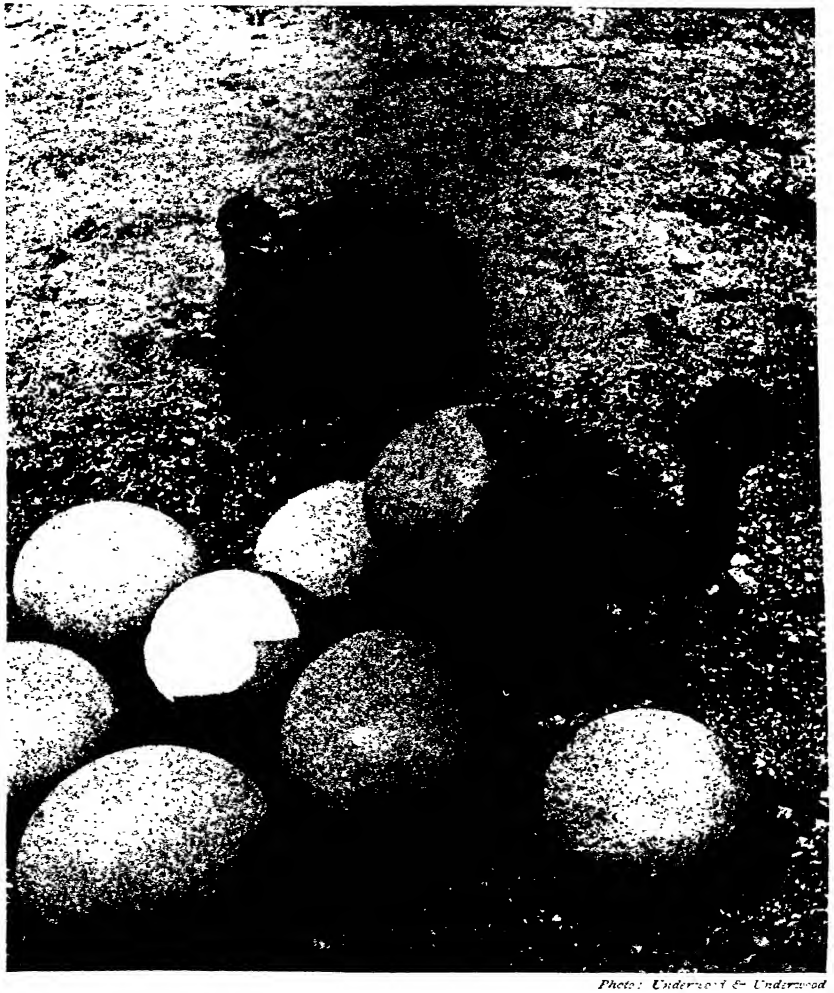


Photo: Underwood & Underwood

Ostrich Chicks, Newly Hatched

In addition to the many eggs laid in the nest, it is stated that others are dropped in the vicinity and broken by the parents to serve as food for the young chicks

Some Curious Eggs

The crocodiles and alligators lay a large number of eggs at a time, varying from twenty to as many as sixty; and in size they may be compared to those of a goose.

They are deposited in a hole excavated out of the sand by the parent, which is afterwards filled in again.

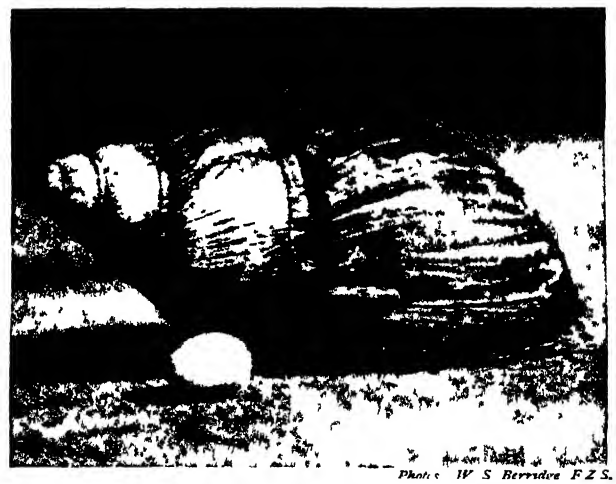
The eggs are then left to hatch under the influence of the heat from the sun; but it appears that at least certain species assist the incubation by taking up their quarters above the position wherein they lie, and it is further stated that, when the young are ready to emerge from the egg, they give warning to their parent by uttering a cry. The mother then promptly digs down to the eggs, and the young break out of the shell by making use of a tooth specially developed for such a purpose.

The tortoises lay eggs, varying in size according to the species responsible for their production, which are placed in holes scraped out of the ground. When the eggs are laid therein, the earth is returned, and to hide all signs of disturbance of the surface, tortoises have been known to stamp it flat with their feet, and even press it firmly with their shell by raising themselves up to their full height, and suddenly dropping down again.

It is not always, however, that the tortoise covers up her eggs, for some merely drop them in crevices, more especially where rocky ground abounds that is full of holes. With all the above creatures, the young are always produced from eggs; but when we consider the lizards and snakes, we find that certain species are viviparous, whilst others hatch them from eggs.

Male Midwife Toad Carrying Eggs

Reticulated Python and its Eggs



East African Giant Snail and its Egg

Some Curious Eggs

Photo H. S. Bernard, F.Z.S.

A Unique Photograph, showing Viperine and Ring Snakes Hatching Out at the London Zoo

The situation selected by lizards as a site for depositing their eggs is usually in a hollow excavated in the sand; but some kinds favour a secluded spot under thick leaves and bushes, whilst less frequently they may be found lying upon the bare sand or rocks, without any attempt being made to conceal them. The large lizards known as monitors are stated at times to deposit their eggs in the nests of white ants— these eggs being about two inches in length, and in some localities much appreciated by the natives as food.

Amongst the snakes, by far the greater number lay eggs, which are oval in shape, and have an external shell of a leathery appearance, and somewhat soft to the touch.

When laid, they are generally left to hatch under the influence of the heat from the sun; or, when deposited in decaying vegetation, as is frequently the case with our common ring or grass snake, to that of the generated heat.

The pythons, however, incubate their eggs by coiling their bodies around them; and it is interesting to note that during that period their bodies develop a temperature of several degrees above their normal one. The boa-constrictors are other large snakes that produce their young from eggs.

With the frogs, we find that the eggs are usually small and very numerous, and held together by a jelly-like substance, from which the tadpoles emerge; but certain of the tree-frogs depart from the more usual proceeding and lay only a few eggs of large size, whilst a land frog found in the Solomon Islands lays eggs the size of marbles, from which fully developed frogs emerge.

Finally, reference must be made to the giant snails that lay large white and perfectly formed oval eggs, as big as those of a sparrow. The snail itself frequently attains to a length of eight inches, and in some parts their flesh is considered as a toothsome morsel to serve at table.

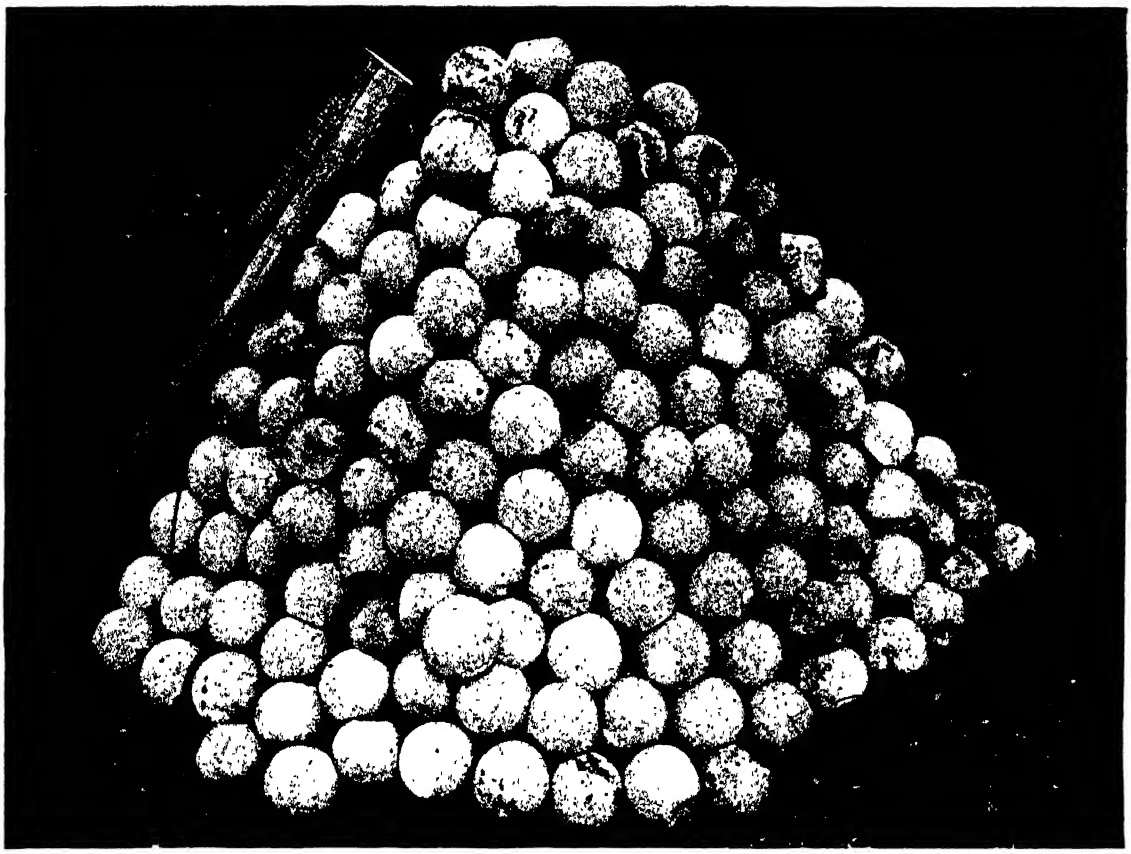


Photo: Florida Photographic Concern

Eggs from One Turtle's Nest

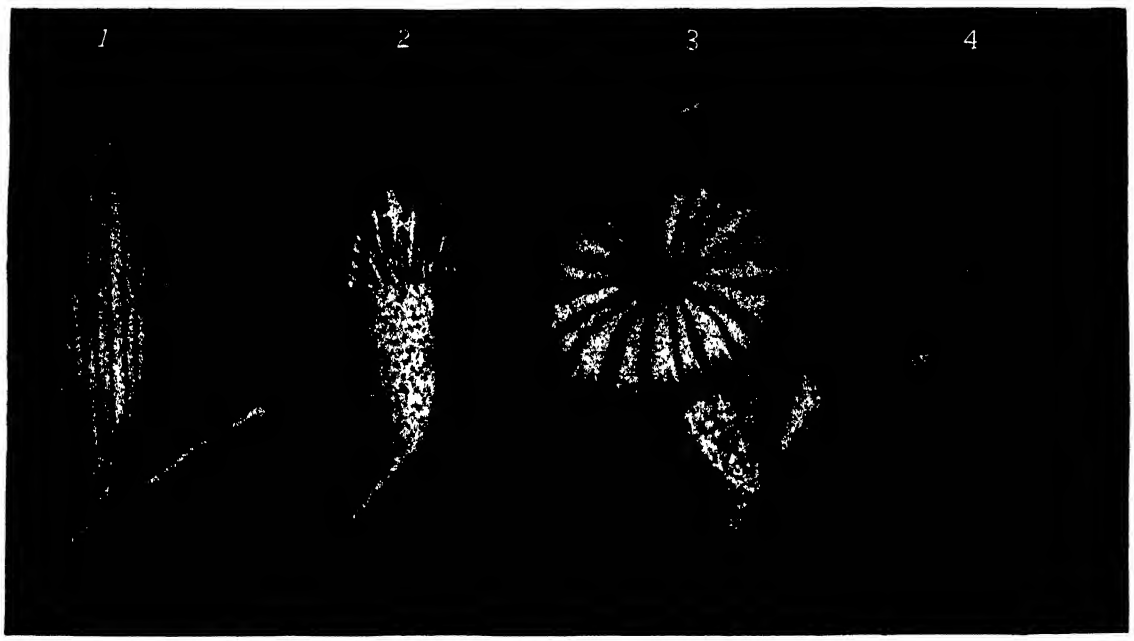


Photo: Harold Bastin

The Eggs of Certain Parasites

1. Egg of parasite of hornbill
2. Egg of parasite of domestic fowl
3. Egg of parasite of the peacock
4. Egg of parasite of the Australian Maleo bird

Panning for Gold near the Fraser River

The Romance of Gold Mining

The New Quest of the Old Golden Fleece

By E. A. BRYANT

Author of "The New Self Help"

JASON'S quest of the golden fleece is still in progress, but the Jasons number many thousands in many lands. Their methods are as various as the lands.

In addition to the genuine latter-day Jason, who pegs down a sheepskin in the gold-laden rivers of Europe, and the pioneer who spreads an ox-hide in the waters of Brazil, there are amalgamated Jasons who, with batteries of stamps and crushers and due equipment of mercury and cyanide, tear the uttermost auriferous grain from the mountain and the reef. All told, these many Jasons, from primitive washings and organised scientific recovery, deliver now to the markets of the world close upon £100,000,000 worth of pure gold per year. The energy by which the "noble" metal is won from its matrix is largely that of the black, the brown and the yellow man. But the white man is lord of all. His is the directing mind, his the capital, his, as a rule, the invincible courage and genius which track the gold home to its mysterious abiding-place. For it is mysterious, not only in its substance, but also, even more so, in its occurrence.

The wisest metallurgist cannot say with certainty how gold was formed, nor can the wisest geologist predict where it will be found, or, rather, where it will not be found. There is gold in circumpolar regions; there is gold in equatorial lands;

there is gold, abundant gold, in Hungary; there is gold in Canada; there is gold in China; there is gold in the Klondyke; there is probably more gold in India than has ever yet come out of that old mint of the world; there is gold enough in Great Britain to run the Bank of England, if we could but discover a method sufficiently economical to make recovery pay.

You may strain it from the waters of rivers winding wearily to sea; you may dig it from the muddy beds of streams run dry in summer. You may scratch it from the dry soil where rivers ran millions of years ago; you may burrow after it into the earthy sides of hills which have been left, sole sentinels of a past where what are now hills formed part of great valleys. You may stumble upon it in nuggets weighing two thousand or more ounces, or blast it out from thin veins of quartz in which it lies, running hither and thither, as on the Rand, where it dips at an angle of thirty degrees, then goes sheer down, like strata of coal. We do not know how it was formed; scientific guessing has resolved itself into a series of well-defined schools to show how it came there. Three defined theories hold the field, though none of them are satisfactory as to the origin of the metal. As to the greatest mines in the world—the Witwaters rand, in the Transvaal—there can be no doubt that where the great reef now lies, a vast sea once washed. It deposited gravel and pebbles which we now know as banket. This banket, a Dutch word, with the accent on the second syllable, means a sort of confection, a rock in which pebbles take the place of almonds. The banket was deposited by the sea.

The rocks were worn down in an age-old past to pretty much their present elevation;

Drawn by R. Caton Woodville from a sketch by Julius Price

Raising Ore at a Siberian Gold Mine

In contrast with the up-to-date machinery in use at most modern mines, in Siberia the old horse windlass is still employed to haul ore to the surface

Photo by permission of the Queensland Government

A Gold Mine on York Island

According to one theory, gold was formed in the sea and brought thence to the land to enter by process of infiltration. According to another, the gold, of which the sea contains vast quantities, infinitely diffused, was conducted to the sea as other terrestrial properties, which will some day form new continents, were conveyed, after frost and storm and rain and wind had done their part in disintegrating the masses from which they were wrested

erosion and weathering having done the rest. The smooth ellipses in which the nuggets, when released from their bed, are found, represent the rounded forms of gold, rolled and tumbled by the tide, as are the smooth and rounded pebbles found on the shore.

So far so easy. But how came the gold there in the first instance? Was it brought in by the sea and precipitated as minute grains or as a chlorine? Or, after volcanic upheavals of the land had given the rocks their present fissured formation, did gold, contained in molten lava, pour out from below to steal into crevices and openings to become solid in the quartz in which it is now discovered? Was gold formed in the sea and brought thence to the land to enter by process of infiltration? Or was the gold of which the sea contains vast quantities, infinitely diffused, conducted to the sea as other terrestrial properties, which will some day form new continents, were conveyed, after frost and storm and rain and wind had done their part in disintegrating the masses from which they were wrested?

Whatever the true answer may be, there is the gold—in rock and banket, in pockets, in veritable mines running from four thousand to five thousand feet sheer into the bowels of the earth; and the problem is to reduce it to hard cash.

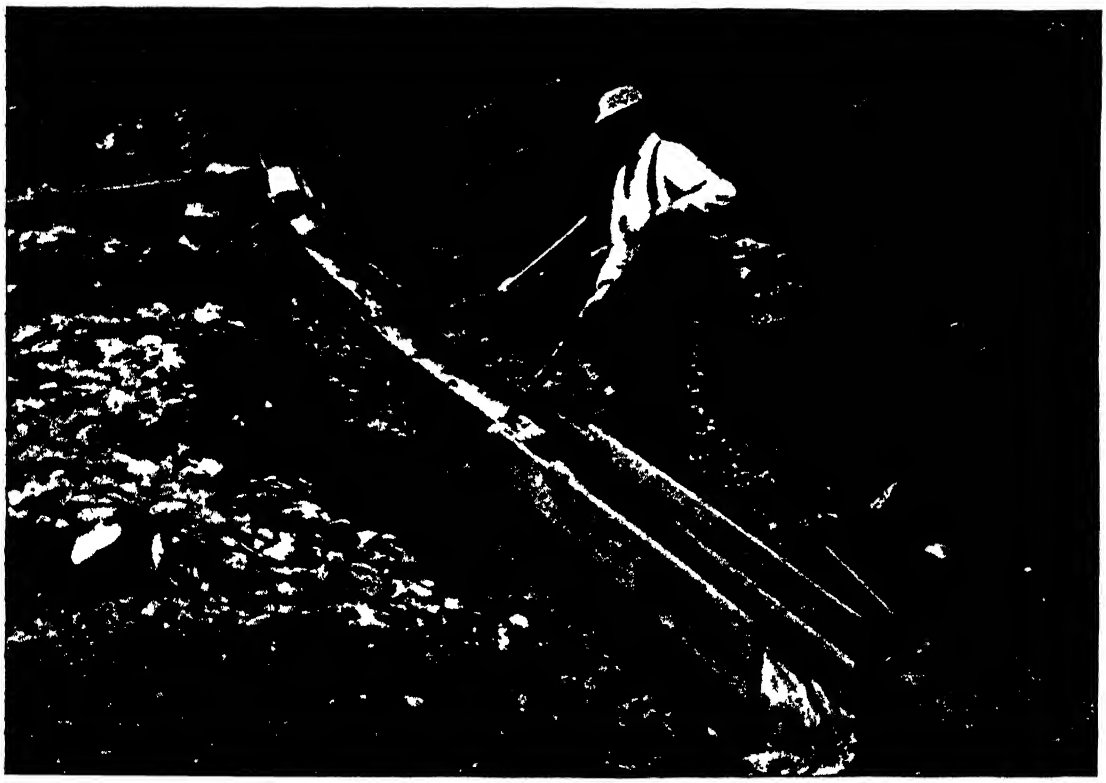


Photo Notman and Son Montreal

Gold-washing at Yale, in British Columbia

The high specific gravity of the gold causes it to sink to the bottom of the "flume," or trough, while the lighter materials are carried off by the current

The process of winning the crude metal from the rock is not vastly different from those employed in riving from their primordial beds the common products of which we make our fires and build our offices. You have the rock drill of the newest pattern, the dynamite charge, the panting black toiling, in plutonic gloom, in quest of the

brightest of metals. He is at the mine only for a time, in order that he may acquire enough money to return to his native kraal, there to become a swell with an extra ox or so, or, if he be of romantic temperament, an additional wife or two.

After the black has finished—we are picturing a fully equipped mine, of course—

Many Processes

the ore has to undergo a variety of processes more varied than most of us imagine. You do not pick up nuggets every day and mint them into sovereigns; you do not seize a lump of quartz and crack gleaming gold from its interior. The scientific miner is one of those wise children of Nature who go back to the great mother of us all for lessons. He seeks to imitate her methods. The banket or rock comes to hand in all shapes and sizes from huge lumps to dust. The black hand sorts them into sizes, and in varying grades they go to the crushing mill, which reduces the largest pieces to uniform walnut size. Next the nuts are treated by the stamp batteries, each stamp comprising a series of mechanically operated hammers, by which the quartz or banket is powdered.

This mixture, well watered, is now allowed to flow over copper plates which are coated with quicksilver. Mercury has a pronounced affinity for pure gold and collects to itself all the unsullied grains, not as such, but taking them to itself and forming an amalgam, from which they will have to be released.

But, fine as is the powdered residuum which escapes the mercury, each tiny fragment is still encapsuled in incredibly small particles of rock. A third crushing by the best means as yet available still leaves particles of gold within particles of rock, and here it is that the chemist takes his lesson from Nature. He employs cyanide of potassium. This it is which is employed to entice the gold from its tiny rocky cave. Saturated with a weak solution of cyanide, the gold leaves the rock from which successive presses have failed to divorce it, and here, as in Nature, we get it in solution similar to that in which, whether from plutonic sources or marine, it was introduced, millions of years ago, into the rocks. But here we have another amalgam, and zinc has now to be employed to lure the liquid gold from its new ally. Under this new influence the gold sinks in grains to the bottom of the tank in which the solution is stored.

It has been pointed out in the *Times* that the delicacy of the whole operation is only to be realised by our knowing that the ore of the Witwatersrand contains on the average only one particle of gold to about 90,000 particles of waste material, yet of this one particle metallurgists recover from 93 to 96 per cent.!

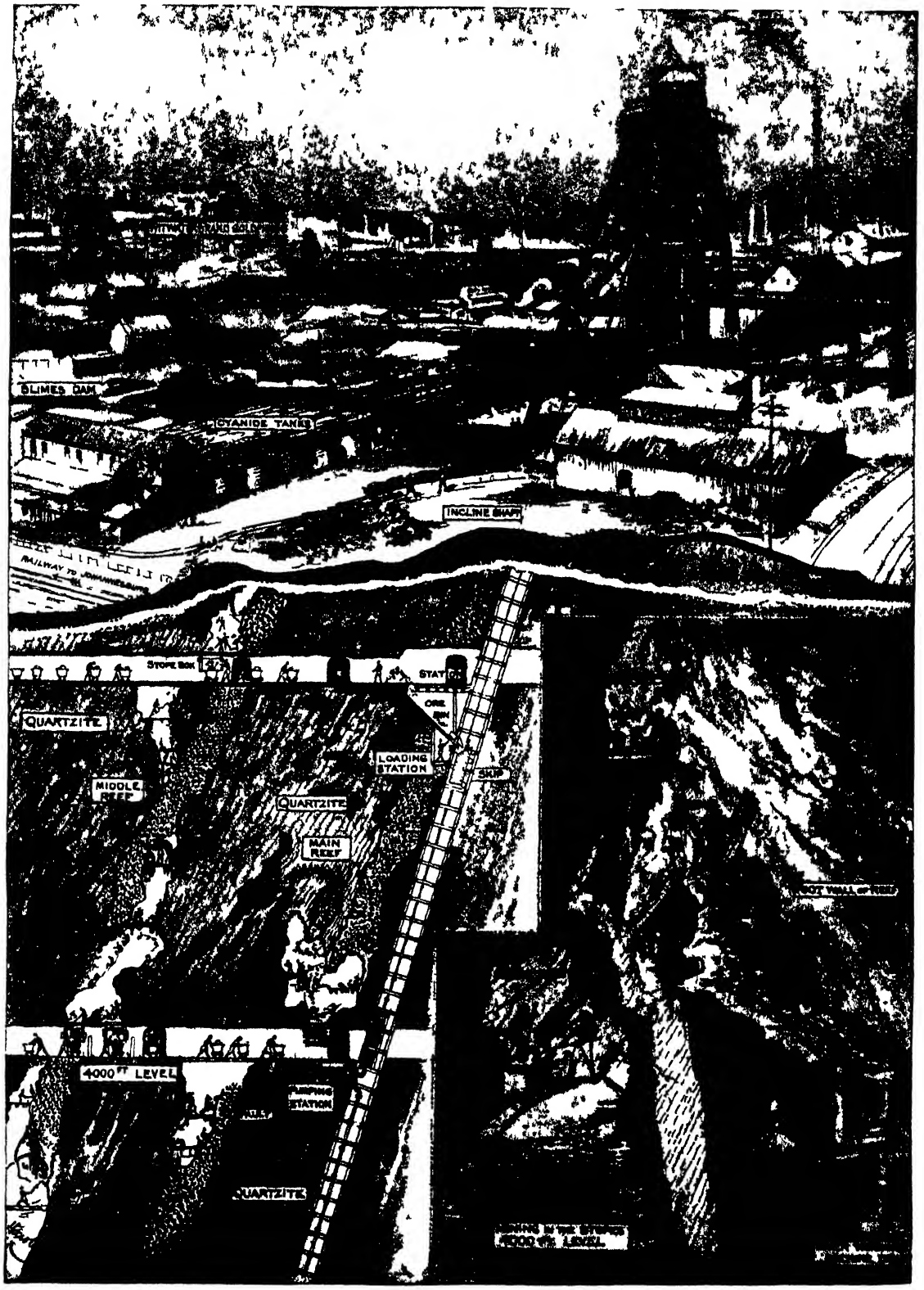
Very different results are returned, of course, from alluvial mining, where more gold may be washed away than is gained, while even more loss is sustained when, in the absence of water, as was formerly the case in the Coolgardie district, fanning is the method employed.

Perhaps the most expensive of all methods, in the sense of gold sacrificed, is what is known as hydraulicking, where water is led by pipes from a certain height and poured from a smaller length of hose upon the gold-bearing material. This, if carried out extensively, not only washes away great quantities of gold, but carries hence such vast quantities of detritus as to choke river beds and render desolate the agricultural land which patient hands are seeking to cultivate in the vicinity.

Still, let us not despise the primitive methods. Some of the greatest romances of mining attach to these.

Klondyke Methods

In parts of the Klondyke, for example, so severe is the weather that the ground scarcely ever thaws to a depth sufficient to admit of proper mining. In that case the men light huge bonfires to scorch the face of the claim at which they are working, roast it into



Section of a Rand Gold Mine

(Drawn by Harold Oakley)

The Witwatersrand goldfields (popularly called the "Rand") are situated nearly 6,000 feet above sea-level on the high veldt of the Transvaal. The goldfields stretch east and west of Johannesburg for fifty or sixty miles

softness, then lay on with pick and shovel. Others, where water is available on the heights and tools generally primitive, conduct the flow through pipes, from the highest point at which it can be accurately directed upon a given point. Lord Armstrong got his first lesson in hydraulics from observing the same process in a state of Nature. Our miner directs his stream of water upon the spot suspected of harbouring gold. So immense is the force of the water that it splits the toughest rock as if it were mere glass.

The story of most of the great nuggets —the Blanche Barkleys and others—are all well known. One less familiar was recorded by the late Francis Train of his Australian days. There was a broken man at an Australian mine, a man who had seen better times, a man of gloomy yesterday and hopeless to-morrow. And when a little company of men who knew him had worked out their claim, they made over to him the whole mine in its entirety. He took a pick next morning and began work at the most hopeless spot, not at the extremity of any of the galleries which had been worked and abandoned, but at the very foot of the shaft, pressed a thousand times by the feet of the men coming and going about their work. Before he had dug long his pick struck something hard. Seeking to get round the boulder, he picked wearily away, revealing more and more of the obstacle. He released it at last, was hauled up with it, sick at heart, determined to give up so hopeless a claim. He was helped into the office where someone exclaimed in rapture that the supposed boulder was a nugget of pure gold.

And then the man who had been ruined but had thus suddenly come to riches, stretched out his arms towards the great mass of gold, and fell across it—dead!

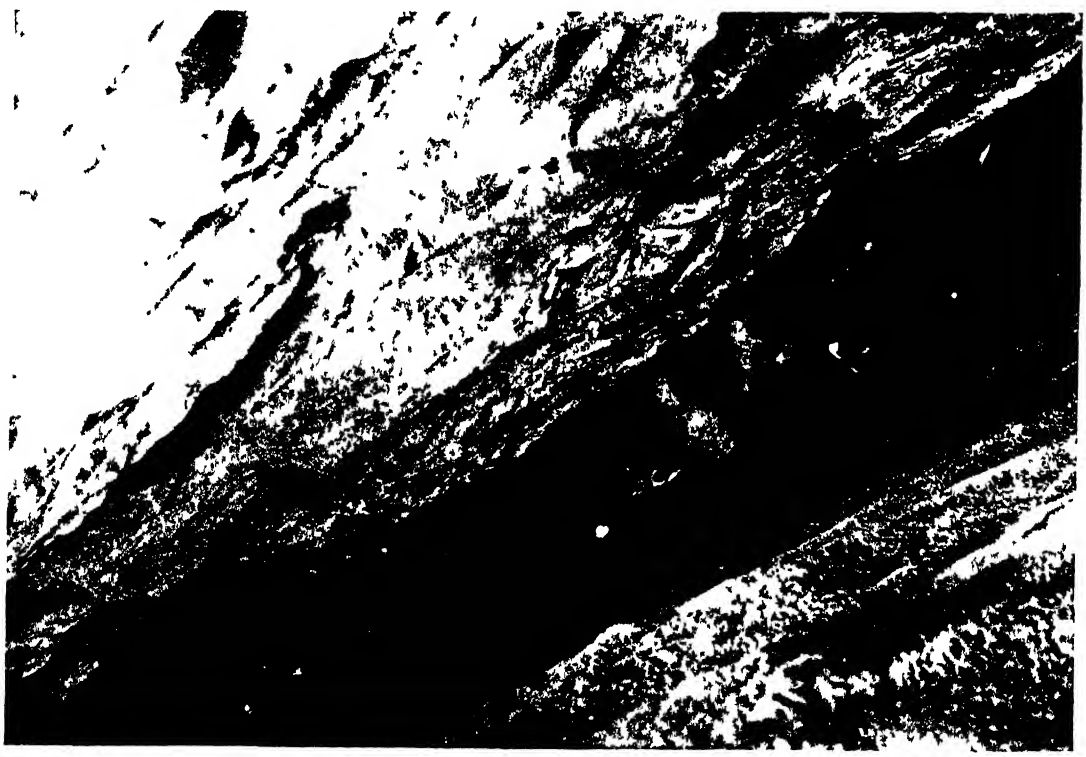
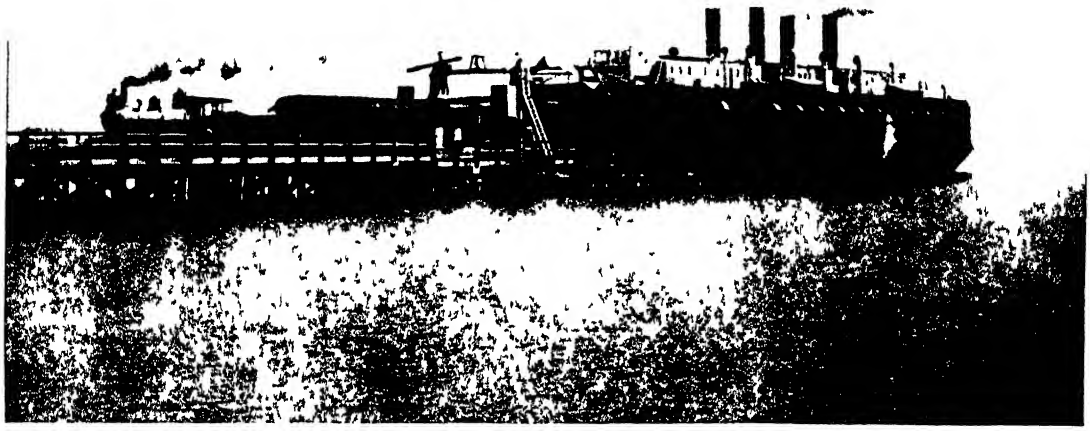


Photo H. J. Collins

Hammer Boys at Work in a South African Stope



Passenger Train Backing Aboard a Train Ferry

Ships that Carry Trains

By H. J. SHEPSTONE

THERE are train ferries in successful operation in various parts of the world—conveying passenger coaches, heavy dining and sleeping-cars, and goods wagons across bays, lakes, and the open sea with the regularity of clockwork. They are to be found in Denmark, Sweden, and Italy, on Lake Baikal in Siberia, on the great lakes of North America, and in the open sea along the coasts of both the United States and Canada.

Naturally, craft designed to carry such heavy and ponderous freight as entire railway trains have to be specially built, and specially engined for the work. They may be described as large double-ended vessels; that is to say, they have neither bow nor stern in the ordinary sense of the term, and are provided with twin screws at each end. On the upper or main deck are lines of rails on which the trains are carried. Like all modern vessels they have double bottoms running the entire length of the ship. These are divided into numerous watertight compartments, the whole being further strengthened by strong bulkheads. These double bottoms serve a twofold purpose; should the lower one be torn away or stove in as the result of grounding or collision, the vessel would still remain afloat, while the water that can be carried in the tanks acts as ballast. Those destined for use upon frozen waterways have smooth, round sides. Thus to the ice they present an unbroken curve, with no angles or projections on which the ice could possibly obtain a hold. This enables them the better to plough a passage through ice of considerable thickness.

Although there are now no train ferries in operation in the British Isles, they had their birth in Scotland. Before the construction of the great bridges over the Firth of Forth and the Tay, railway wagons

were regularly ferried across these waters in specially designed steamers. One ran from Granton to Burntisland, across the Firth of Forth, a distance of 5½ miles, and the other across the Tay at Dundee, a journey of just under the mile. A specially designed steamer, the *Leviathan*, 172 feet long, 54½ feet wide, with a draught of 6½ feet, carried the trucks bodily across the

The Train Ferry "Thoroughfare" at San Francisco

Firth of Forth, often conveying as many as 240 a day.

In European waters the finest train ferry systems are undoubtedly those of Denmark, where we find ships carrying both passenger and freight cars over wide stretches of open sea.

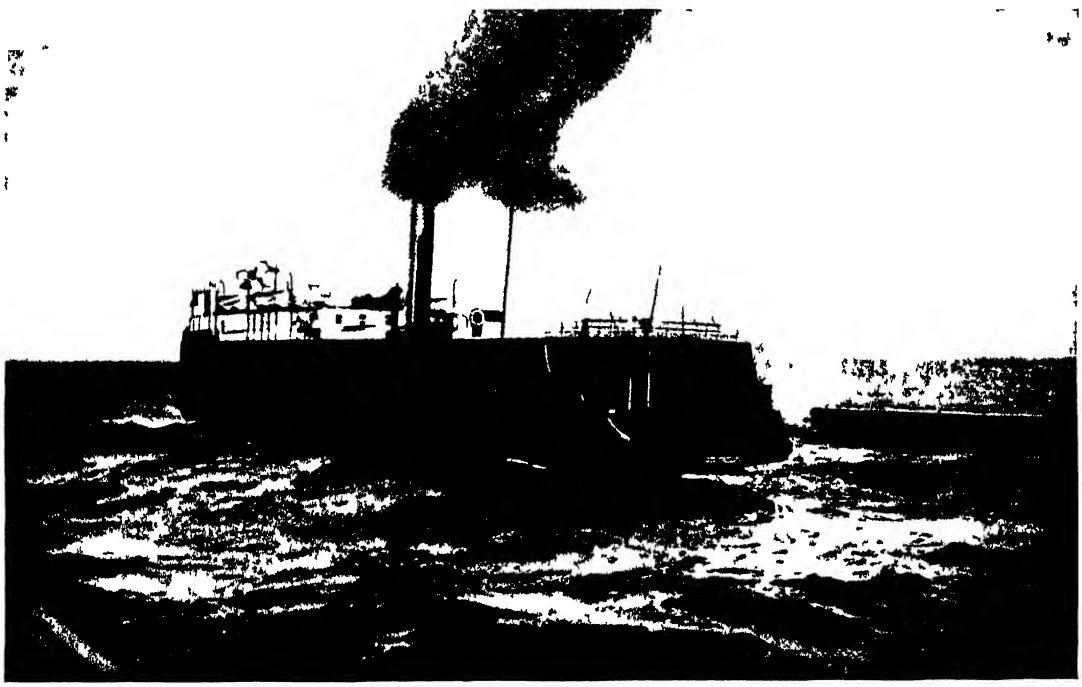
The steamers employed vary from 250 feet to 300 feet in length, and possess a speed of 13 knots to 15 knots. Generally speaking, the harbour at the rail-head comprises a number of large docks, which are furnished with an exterior row of unsunk piles, joined to the inner by means of spring buffers. Thus the sides of a dock are formed of elastic walls, so to speak, which arrangement simplifies the work of navigation. Entering or leaving, the captain has nothing to fear from a collision with the piles, and so can manœuvre his vessel at a rate of speed which otherwise would be rash. The steamers lie alongside the stage, with what is their stern, for the time being, backed into a smaller dock. The farthest end of the latter is spanned by an ornate bridge-like erection, from which is suspended a movable gangway, connecting the line of rails on shore with the lines laid on the upper deck of the vessel. This travelling platform is lowered, according to the tide, entirely by mechanical, in contradistinction to "power," means. The vehicles to be transported are pushed on board by a small shunting locomotive. If the sea promises to be rough their wheels are scotched, and they are clamped to the metals by means of screw-couplers, which bite each rail and each buffer-rod. During the voyage the buffers, brake mechanism,

and other metal work, are swathed in oil-skins. On reaching the opposite port a gangway is lowered as before and locked to the deck, and the carriages are then drawn off through the opposite end by an engine, which goes aboard for them.

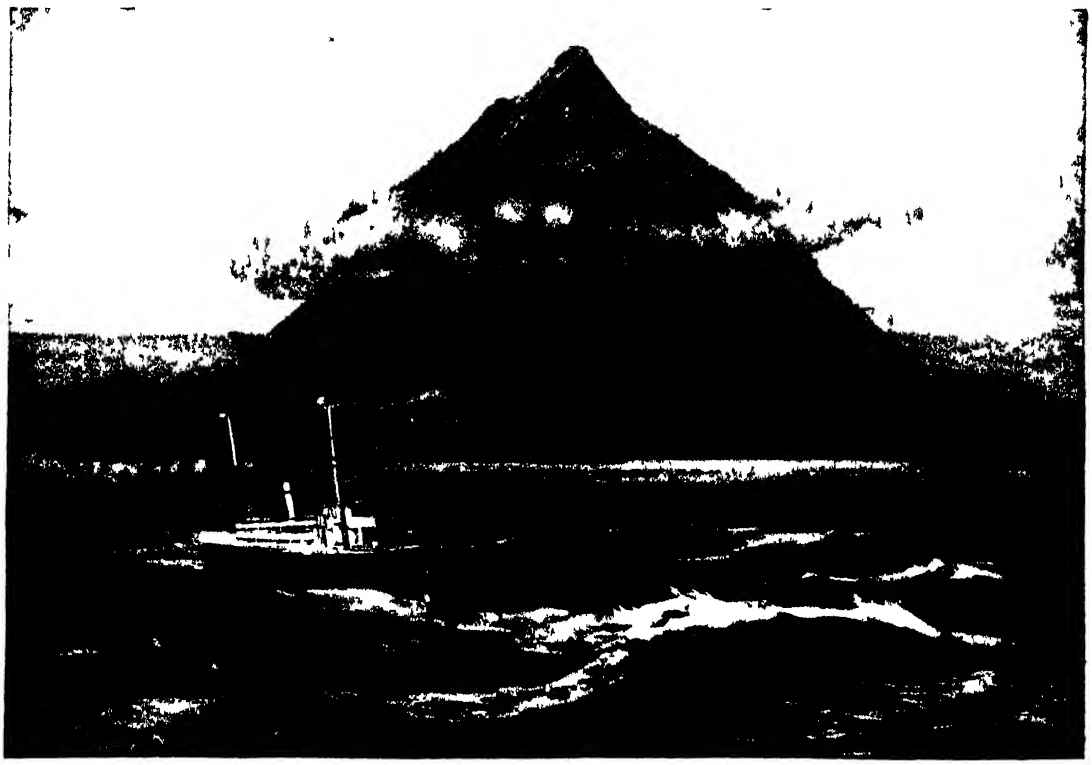
Four through trains are run daily across the Gjedser-Warnemunde ferry, from Berlin to Copenhagen, including a restaurant day train and a sleeping-car night train. Hundreds of passengers making this trip at night in the sleeping-car wake up at Copenhagen or Berlin next morning apparently oblivious of the fact that they have been twice borne over the sea. On every up-to-date ferry-boat passengers can alight from the coaches, if they so wish, and stroll about the ship. On the lower deck there is a dining-saloon, and on the upper deck smoking and sitting accommodation.

In Italy there are train ferry-boats running across the Straits of Messina, from Messina to Reggio, and from Messina to Villa San Giovanni. On Lake Baikal, in Siberia, two train ferry steamers are in constant operation, the newer and larger one being the *Baikal*, built for the Russian Government on the Tyne. This vessel is 290 feet long with a 57 foot beam. She has three sets of rails capable of accommodating twenty-five railway coaches. More wonderful still she can plough her way through ice five and six feet in thickness.

In America there are some seventy-eight ferry lines in operation, the most interesting being those found on Lake Michigan. This sheet of water has an area of 22,450 square miles—nearly four times as large as the county of Yorkshire. During the winter months this vast lake is anything but a placid sheet of water. In stormy weather waves from 20 feet to 25 feet high are encountered, while in the depth of winter there is the ice, both solid and in floes, to be surmounted. Yet every day of the year hundreds of trains are safely conveyed over this great inland sea by up-to-date ferry-boats, designed to carry heavy railway coaches, to battle against storms, and to fight a passage through the ice.



Loaded Train Ferry Leaving Harbour



Drawn by Dudley Tennant

The Peak of Teneriffe—a Relic of Old Atlantis

The Drowned Continent of Atlantis

The "Fable" of a Vanished Land Proved True by Geology

By ARTHUR HOLMES, A.R.C.S., F.G.S.

OF all the lost continents which science seeks to restore in studying the geography of the past, none awakens so vivid an interest as Atlantis. The clear and simple story unfolded by Plato twenty-three centuries ago, is, if it be true, an account of the most frightful disaster which has ever befallen a great nation. Let us listen to the words of Plato. Solon, famous as the wisest of the seven sages, a great Athenian legislator, who lived about 600 B.C., had made a voyage to Egypt. While there he was profoundly impressed by the story of an old Egyptian priest who revealed to him the early and long-forgotten history of Athens. The venerable tradition runs as follows:—

"Many great and wonderful deeds are recorded of your State in our histories; but one of them exceeds all the rest in greatness and valour; for these histories tell of a mighty power which was aggressing wantonly against the whole of Europe and Asia, and to which your city put an end.

"This power came forth out of the Atlantic Ocean, for in those days the Atlantic was navigable; and there was an island situated in front of the Straits which you call the Columns of Heracles: the island was larger than Libya and Asia

put together, and was the way to other islands, and from the island you might pass through the whole of the opposite continent which surrounded the true ocean; for this sea which is within the Straits of Heracles is only a harbour, having a narrow entrance, but that other is a real sea, and the surrounding land may be most truly called a continent. Now, in the island of Atlantis there was a great and wonderful empire, which had rule over the whole island and several others, as well as over parts of the continent; and, besides these, they subjected the parts of Libya within the Columns of Heracles as far as Egypt, and of Europe as far as Tyrrhenia.

Empire of Atlantis

"That vast power, thus gathered into one, endeavoured to subdue at one blow our country and yours, and the whole of the land which was within the straits; and then, Solon, your country shone forth, in the excellence of her virtue and strength, among all mankind, for she was the first in courage and military skill, and was the leader of the Hellenes. And when the rest fell off from her, being compelled to stand alone, after having undergone the very extremity of danger, she defeated and triumphed over the invaders, and preserved from slavery those who were not yet subjected, and freely liberated all the others who dwelt within the limits of Heracles. But afterwards there occurred violent earthquakes and floods, and in a single day and night of rain all your warlike men in a body sank into the earth, and the island of Atlantis in like manner disappeared, and was sunk beneath the sea. And that is the reason why the sea in those parts is impassable and impenetrable, because there is such a quantity of shallow mud in the way; and this was caused by the subsidence of the island."

In the face of this precise description, it is difficult to believe that there was any doubt as to the location of the great empire which suffered this appalling catastrophe. Yet, after the Renaissance, when men began seriously to discuss the Atlantis legend, there were numerous attempts made to rationalise the story. In the seventeenth century Sweden was identified with the fabled continent, and one ingenious author, associating the unknown terrors of the North Pole with the unprecedented horrors of the night when Atlantis was sunk beneath the pitiless waves, believed that the ill-fated land once formed a mighty Arctic continent. Others placed Atlantis in the eastern basin of the Mediterranean, where it would include the Palestine of to-day. The obvious position, however, is clearly marked by the four groups of islands which rise from the uneven bed of the Atlantic beyond the Straits of Gibraltar —the Azores, Canaries, and Madeira, and the Cape Verde Islands.

What has modern science to say about the sombre tale so convincingly related by Plato? Is it merely to be treated as a fable? It is true there may be a mythological basis for the story. The ancient Celts believed in a gloomy land of the dead which they called Avalon, and which lay over the western seas beyond the sunset. It is thought that Avalon may also have figured in Greek legends as the Gardens of the Hesperides or as the Isles of the Blessed. The next step in the mythological explanation is to assert that these imaginary lands were one with Plato's Atlantis.

Let us now turn to the evidence afforded by the actual region in question. Taking a bird's eye view of the floor of the Atlantic, supposed for a moment to be visible through the thick blanket of water which covers it, we should see a long, S-shaped central ridge or plateau, bordered on each side by immense depressions, the whole structure being roughly parallel to the shores of the neighbouring continents. The eastern trough, while less deep than the western one, is narrower and more irregular and broken in its features. Great

The Atlantic Floor

mountain massifs rise abruptly from its deepest points, or from the eastern slopes. The three greatest of these, piercing the mantle of ocean water, raise their black volcanic heads into the sunshine and form the islands of Madeira, Canary, and Cape Verde. The central elevation bears the Azores upon its scarred and crumpled surface, as well as a number of submarine peaks which do not succeed in reaching sea-level. In brief, the bed of the Atlantic, with its plateaux and basins, ridges and depressions, is reminiscent in no slight degree of a mountainous country, and detailed soundings are continuously revealing submarine hills and valleys which were not previously suspected.

Geology's Testimony

The testimony of geology must now be considered. The curious winding shape of the Atlantic bears no relation to the structures of the adjoining lands. During the long ages of geological history, four great mountain ranges have rolled, like gigantic waves, across the northern hemisphere, each one rising a little farther south than its predecessor. The Alpine system of mountains still remains, but the older ranges are represented only by their deeply dissected roots. Nevertheless, their directions are imprinted indelibly upon the rocks, and in every case it is found that the Atlantic cuts abruptly across the grain, a statement which applies to the American as well as to the European and North African shores. Moreover, many of the folds on the eastern side appear to be in direct continuity with others of the same age on the western side.

This is particularly clear in the case of the Hercynian range, which hundreds of millions of years ago must have rivalled the Alps and Himalayas in immensity. The planed-down base of these mountains passes under London, but the old folded rocks can be traced westwards at the surface from Devonshire, across South Wales, into Cork and Kerry. Although the various ridges all run abruptly into the Atlantic, similar folds can be picked up on the other side in Nova Scotia and Newfoundland. The conclusion seems unavoidable, that at one time a chain of folded mountains, not unlike those of Central Asia, stretched across what is now the North Atlantic.

In the south, it is probable that much of South America, Central Africa, India, and Australia were all part of a great continent which has been christened Gondwanaland. North of this ancient land-mass, or of the relics which survived, was the original Mediterranean—an old sea which is known to geologists as the Tethys. It lay east and west, and extended from the West Indies, across the Atlantic, and the present Mediterranean, and far across Asia to the Pacific. The present Atlantic has been formed at the expense of the land which then occupied its northern and southern basins, and of the water of the gradually shrinking Tethys. The land areas were broken across the grain of their folded rocks, and, as they foundered, the Atlantic slowly extended its shores.

A Volcanic Zone

A great volcanic zone stretches along the eastern side of the Atlantic from Iceland to Tristan da Cunha. All the islands lying beyond the Straits of Gibraltar are of volcanic origin, and are built up almost entirely of ashes and lavas. It is particularly significant that many of the lavas are of a peculiar kind, rich in soda and potash, which is limited almost entirely to those regions of the earth that have suffered subsidence. But much more important for our purpose is a discovery which was made in 1898. During that year a cable ship was employed about 500 miles north of the Azores in repairing a cable which had been broken. For several days it was necessary to explore the ocean bed in order to find the broken ends. The mean depth of the water was nearly 10,000 feet, but the bottom was exceedingly irregular,

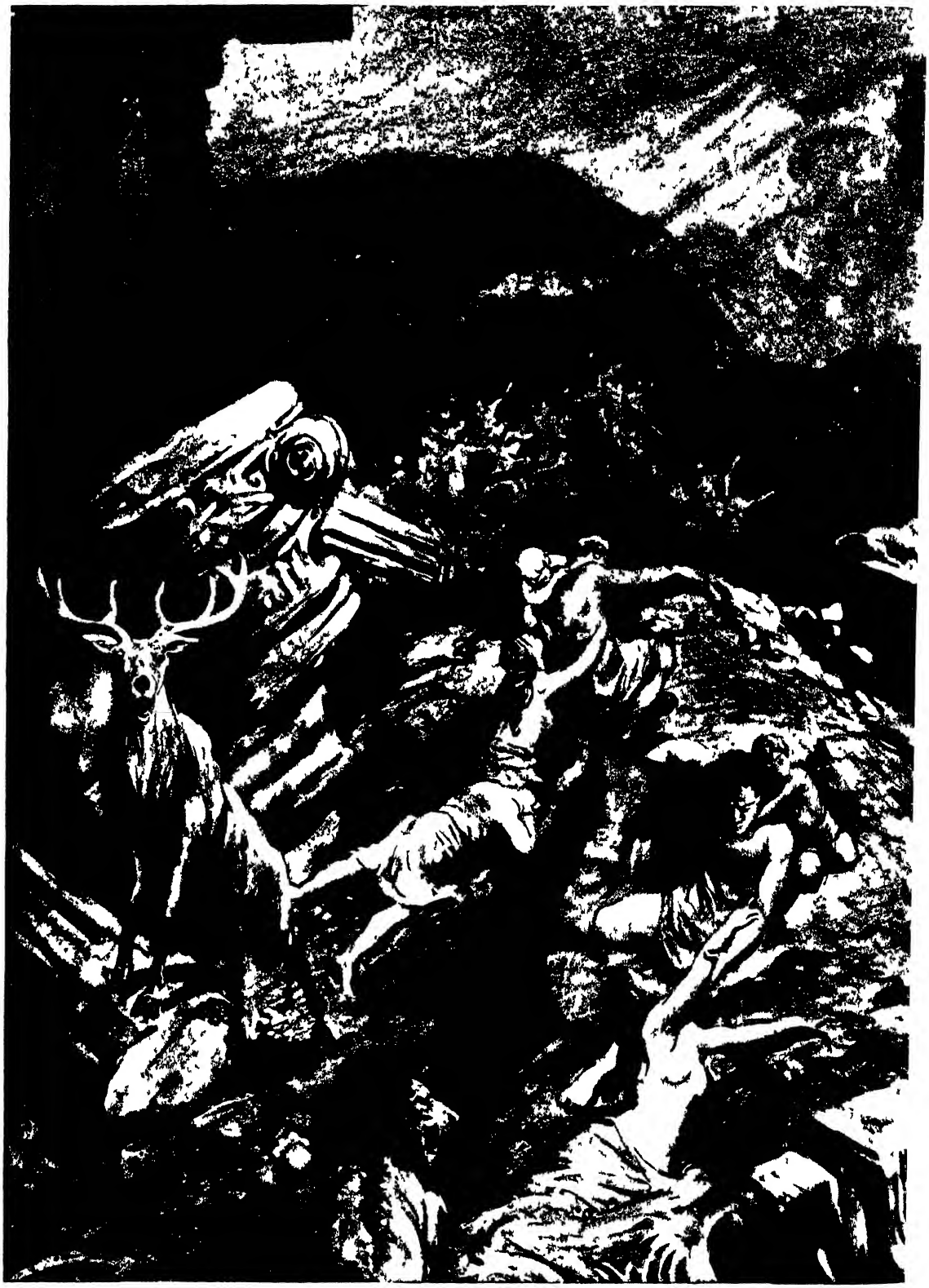
jagged rocky peaks alternating rapidly with deep valleys in which a little soft mud had accumulated. The hard, angular ridges scratched and sometimes even broke the grappling irons, and in the teeth of the latter, freshly broken pieces of the rocks from the sea-bottom were brought up. It lava can only form a glass when it is cooled so quickly, and under so low a pressure, that crystals have not time to form before the mass has solidified. Now, under any considerable depth of water, the pressure would certainly promote crystallisation, in spite of the chilling effects of the water, so that

The Harbour of Santa Cruz, Teneriffe

In former days a great continent with a mighty civilisation flourished where now a few islands alone remain

was found, to the great astonishment of those who realised the meaning of the discovery, that the fragments which had been torn from the submarine pinnacles consisted of a glassy lava having the composition of a basalt.

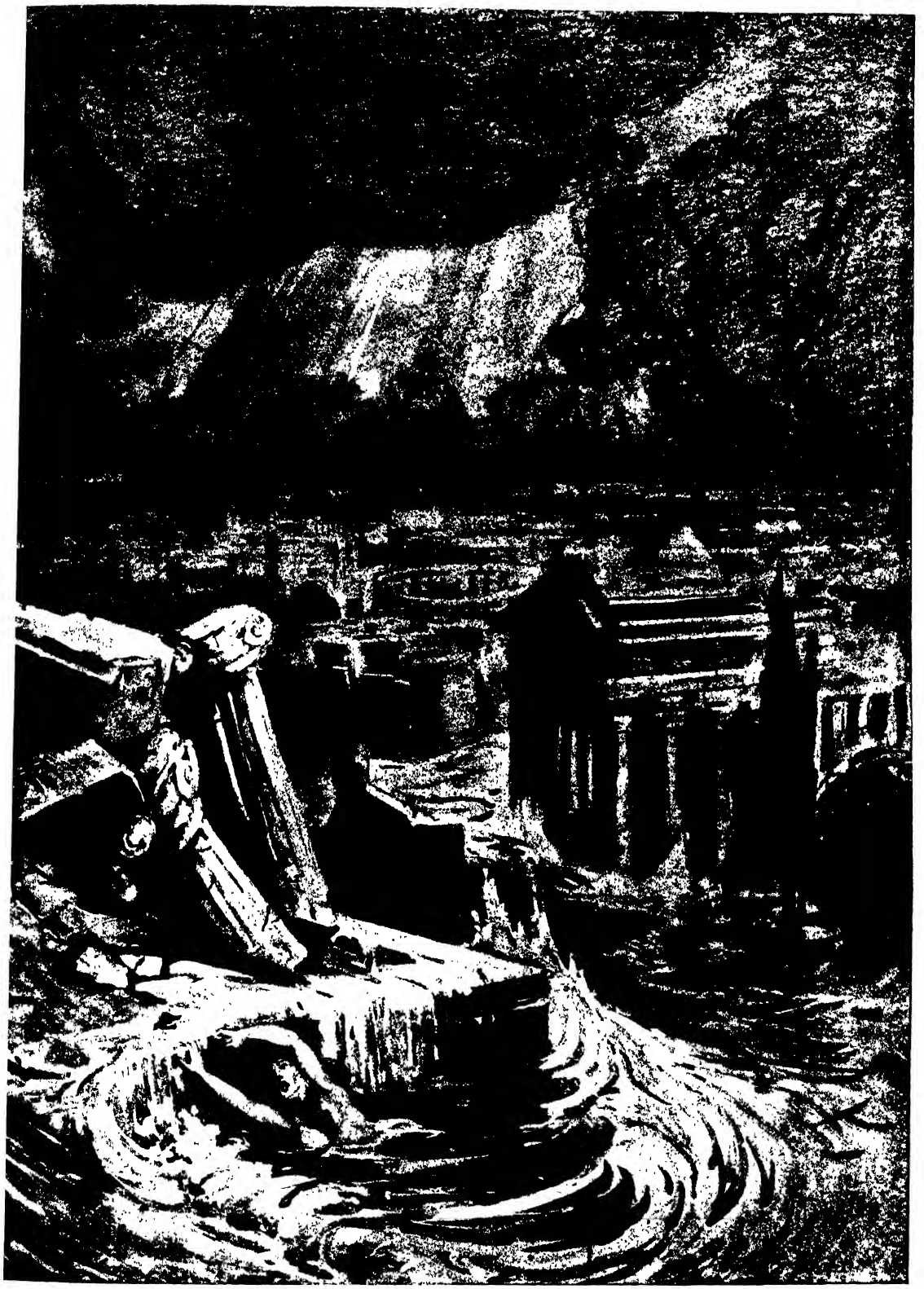
Everyone is familiar with the fine-grained crystalline rock which is known as basalt. It is extensively used as road metal, and in its most famous natural occurrence in Britain it builds the remarkable columns of the Giant's Causeway. A molten basaltic a glass would be unable to form. We are thus led to the interesting conclusion that the sea-bottom north of the Azores consists of lava-flows which were probably extruded while the area was still occupied by land. If this conclusion be accepted—and it rests upon the authority of the French savant, M. Thermier—a further deduction can be made. If the ancient land surface has preserved its glassy and therefore most superficial rocks, if it has retained its rough and tormented characters, then it follows



THE AWFUL CATACLYSM IN WHICH, ACCORDIN

(*Drawn*

The ancient legends which state that the whole continent was drowned in a single night are undoubtedly mistake
Finally, however, a great earthquake, accompanied by the other manifestations shown he



) PLATO, ATLANTIS DISAPPEARED

ley Tennant)

: subsidence was probably spread over a number of centuries until, from a continent, only a large island remained. / have heralded the swift inrush of the sea and the utter destruction of a civilised nation

that the waves had not time to plane it down as it sank. Finally, we learn that this profound entombment must have taken place with, geologically speaking, extraordinary rapidity, very shortly after the eruption of the lavas.

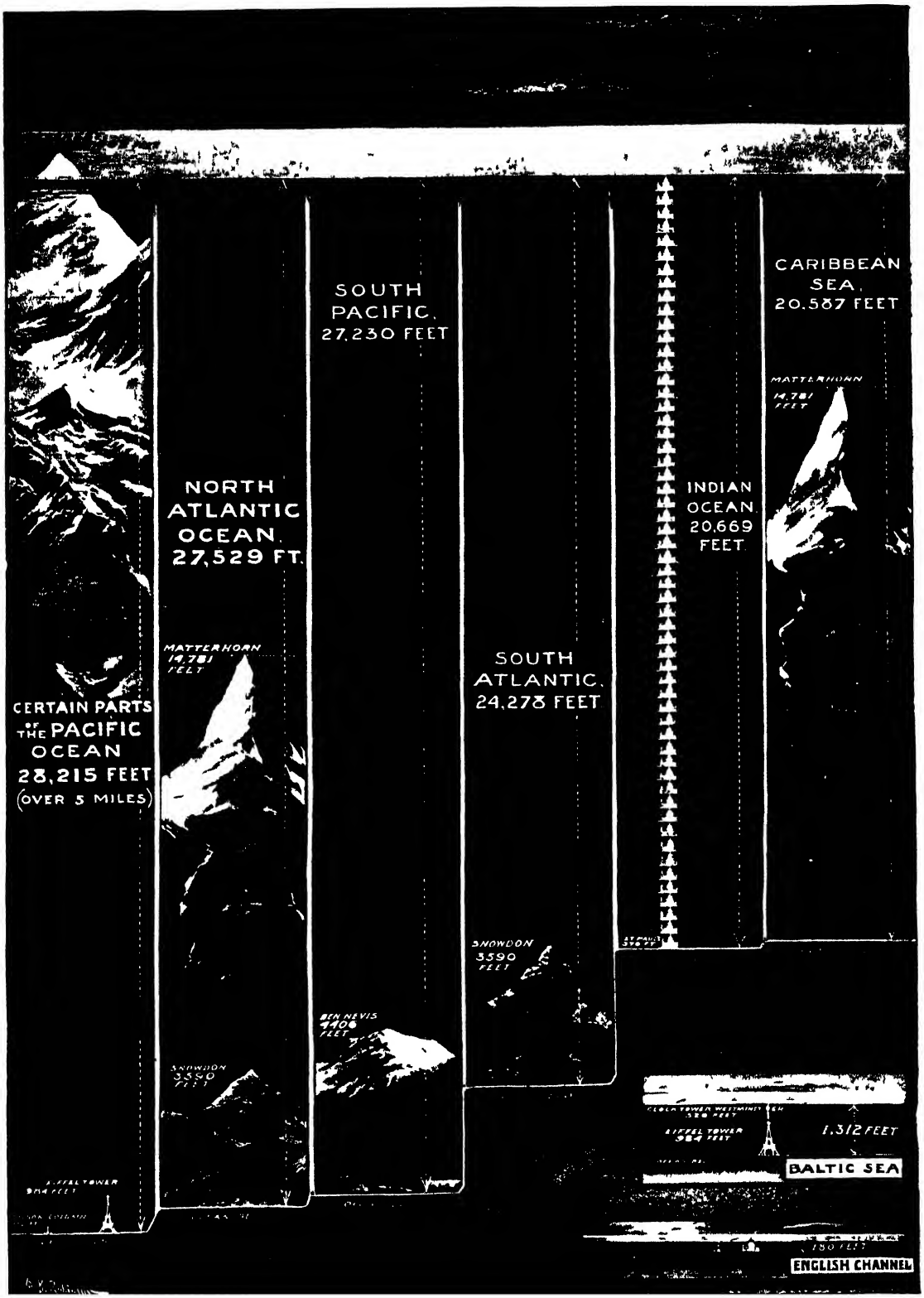
The Biologists' View

Having now learned something of the geological history of the Atlantic, we may briefly review the conclusions to which biologists have come in dealing with the same difficult problem. It is believed that the mammals of the Azores came directly from Europe by a land bridge, which is now submerged. The molluscs and corals of the Atlantic islands indicate that a continent must have stretched from Portugal and North Africa to Florida and the West Indies in Miocene times. Many species, both fossil and living, are found around the shores of the Canaries and of Madeira, which are unknown elsewhere, except in the Western Mediterranean, and along the coasts of Florida and the Bermudas. This curious distribution cannot be attributed to marine currents, as in some cases the larvæ cannot live in the open ocean for more than a day or two. The southern part of the transatlantic continent was probably under desert conditions, like the Sahara of to-day, for the fauna of the Canaries and the Cape Verde Islands includes a number of characteristic desert forms.

It is this continent which was the true Atlantis. Since Miocene times, perhaps twelve million years ago, it has been breaking up, and foundering piece by piece, until to-day only a few islands remain, marking the positions of the greatest of the volcanoes which were goaded into activity by the intense terrestrial disturbances.

There can be no doubt that the Atlantis of Plato was the last great earth segment to be drawn into the ocean abyss. So far we may safely go, but whether this continent was peopled with men who gradually built up a highly civilised empire cannot yet be decided. There is, however, nothing improbable in that supposition, supported as it is by the detailed accounts given by Plato, and by the resemblances between the myths and legends, religions, and languages of the races of both sides of the Atlantic. What it is difficult to admit is that a large area of country should have been swept out of existence by a paroxysmal disaster in the short space of a single day and night. It is a frightful conception. On one day the people of Atlantis are busily occupied in their splendid city just as usual, a little anxious perhaps for their warriors over the sea, and, it may be, somewhat troubled by the trembling of the earth. The next day sees the imperial tragedy begun, and on the day following, the ocean, cruel and unconcerned, ebbs and flows where a mighty nation had flourished. Fortunately, perhaps, for our peace of mind, the changes of level which are recorded in the story of the earth as it is told by the rocks are not of this extreme catastrophic type. That Atlantis existed, first as a continent and then as an island, we may readily admit. That in its last days it was populated by a civilised race, we may also consider to be more than a myth. That it was rapidly engulfed by the sea, we have found to be a geological necessity, but "rapidly," in the geological sense, may yet mean centuries of steady subsidence. The night of terror in which Atlantis was added to the bed of the ocean that now bears its name has nothing to support it except the nine thousand year old story told to Solon 2,500 years ago.

A Night of Terror



Seas Deep Enough to Engulf Mountains

(Drawn by W B. Robinson)

This diagram graphically illustrates the fact that the ocean is deep enough to engulf any existing continent, and leave no surface sign, save for an island, here and there, where the highest mountain peaks peep above the water

Totems and Totemism

A Wonder of Human Instinct—Concerning the Ingenious Means by which Eugenic Laws are Upheld among Savages

By J. A. BRENDON

Author of "Twelve Great Passions," &c.

THE word "totem" was first introduced into English in a book written in 1791, by J. Long, an interpreter between white men and Red Indians in North America.

Long used the word to denote the protective familiar which each Indian selected for himself. But it has a very much wider significance than this. In stricter terminology it denotes the class of material objects—generally of a natural species, animal or vegetable—which gives its name to a kindred, actual, or supposed, among many savage and barbaric races in Australia, Asia, Africa, and America.

A Protective Familiar

The supreme or superior being of savage religion or mythology is never a totem. A totem, moreover, is quite distinct from a fetish, in that it is never an isolated individual, but always a class of objects.

Roughly speaking, totems are of three kinds. First, there is the individual totem of which Long made mention. This belongs only to one man, and does not pass to his descendants. Secondly, there is the sex totem, which may be common either to all the males or to all the females of a tribe; and, thirdly, there is the clan totem.

The latter is the most important. The clan totem, in fact, is shared in common by a whole clan; it passes by inheritance from generation to generation; and the body of men and women to whom it gives its name believe themselves to be of one blood, descendants of a common ancestor, and bound together by mutual obligations.

For example, the Turtle clan of the Iroquois—a tribe of North American Indians—believe that they are descended from a fat turtle, which was so greatly burdened by the weight of its shell that it contrived at last to throw it off, and then gradually developed into a man.

Similarly, the Haidas of Queen Charlotte Islands think that the raven—which figures prominently in the mythology of the north-west coast of America—took a cockle from the beach and married it; that this cockle gave birth to a daughter, whom in due course the raven took to wife; and that to their union the tribe owes its origin.

The fact that members of a totem clan are bound together by mutual obligations, and have a common faith in the totem, gives to totemism both a social and religious importance.

Seeing that he thinks himself to be descended from his totem, the savage naturally treats it with great respect. If it be an animal, he abstains, so far as possible, from harming or killing it; if it be a plant or vegetable, he is very reluctant to make use of it.

Totem Animals

An Indian of British Columbia will never kill his totem animal; even if he sees another man do so he will hide his face for shame, and later demand compensation. Some tribes, on the other hand, will kill the totem animal when hunger compels; and others if it happen to be a dangerous animal, such as a lion. But in both these cases the slayer afterwards

Totem Poles

Roughly speaking totems are of three kinds First there is the individual totem This belongs only to one man and does not pass to his descendants Secondly there is the sex totem which may be common either to all the males or to all the females of a tribe And thirdly there is the clan totem

must go through an elaborate form of purification for the sacrilege.

The Oraon clan of Bengal, whose totem is the Kujrar tree, will neither eat the oil of that tree, nor sit in its shade; whilst the Bechuanas in South Africa are forbidden to eat, or to clothe themselves in the skins of the totem animal.

The Crocodile clan, to quote another case, regard it as unlucky even to gaze on a crocodile, and think that the sight causes inflammation of the eyes. Hence a Crocodile man, when he finds himself near his totem animal, will spit on the ground, and say, "This is sin."

Yet that same man will call the crocodile his father, will swear by it, honour it, and pay most reverend homage to it at festivals.

The penalties incurred—or rather, supposed to be incurred - by disrespectful conduct towards the totem vary considerably.

It is thought that boils and white spots will break out on the body of any member of the Elk clan of the Omahas, in North America, who touches any part of the male elk, or eats of its flesh; whilst a Turtle man of the Samoans believes that, were he to eat a turtle, the creature would continue to grow and thrive, until at last its voice would be heard inside him, saying: "He ate me; I am killing him."

Death or sickness seem generally to be accepted throughout the continent of Australia as the punishment for eating the totem.

But if a man treats his totem with respect, he assumes that the totem, for its part, will assist and protect him.

The Kurnai of Victoria, for example, regard the crow as one of their ancestors, and think that it watches over them, answering their questions by cawing.

The Owl clan of the Samoans, again, looked to the owl on all occasions for omens and portents; and so sure of the totem's protection were the Psylli, a snake clan in Africa, that they used to expose their new-born children to snakes so as to determine any question that might arise as to their legitimacy.

In order fully to secure its protection, a clansman usually endeavours in some way to assimilate himself to the totem.

Maybe he will wear the skin of the totem animal, as do the Minnitarees, a tribe of North American Indians, who always go to battle clad in wolf skins.

Photo Burton Bros, Dunedin

A New Zealand Totem Sign

Maybe he will depict the totem on his body by means of scars, paint, or tattooing. Or perhaps he will arrange his hair or mutilate his body in such a way that he may present some resemblance to the totem. Each member of the Buffalo clan of the Iowas, for example, always wears two locks of hair in imitation of a buffalo's horns.

Further, it is usual for a clansman to employ his totem mark as a signature to documents, and to have it carved or painted on his hut and weapons. In some cases a post containing a carving of the totem is erected in front of the clansman's house; in others, where the totem is an

animal, a skin is stuffed and stuck on a post before the door.

Births, Marriages, and Deaths

Births, marriages, and deaths, again, are invariably attended by elaborate ceremonies which directly aim at identifying a man with his totem. Men of the Hot-Wind Clan of the Australian Wotjoballuk are buried with the head in the direction from which the hot wind blows; those of the Sun clan with their heads towards the sunrise.

The Kalang of Java have the red dog for their totem. Before marriage, therefore, brides and bridegrooms of the tribe are rubbed in the ashes of a red dog's bones.

Similar rites mark the attainment of puberty.

That this should be the case is explained by the fact that the fundamental rules governing totem society are those which regulate marriage and the relation of the sexes.

It may be laid down as a general law that in no country where totemism prevails may a man unite with a woman of the same totem as himself. It should be noted, moreover, that although disregard of the "religious" rules relating to the totem is thought, as has been shown above, to be punished automatically, the clan itself interferes when the marriage rules are violated, and punishes offenders, the usual penalty being death, or at least tribal excommunication.

And, since everyone must bear the totem mark on his body, either in the shape of a tatoo or some similar sign, no one can plead ignorance in condonation of his offence.

To the rule forbidding marriage within the totem there is one exception—namely, among the Arunta "nation" of Central Australia. But here children do not inherit totems from either of their parents. Each child derives its totem from the place where the mother first becomes conscious of the new life that is to be.

The explanation to this system is curious, and at the same time of great importance. The Arunta believe that the spirits of some primal race, in groups of one totem only, inhabit various localities, eagerly seeking to re-enter mundane life via the body of a baby.

Thus, if a mother, whatever her own totem may be and whatever her husband's, becomes aware of the new life while passing through a known centre of wild cat spirits her child's totem will be wild cat.

Among the Arunta, therefore, two persons may be of the same totem without being connected by any tie of blood or natural kinship. This being so, one can but assume that the peoples elsewhere, who enforce the marriage prohibition, recognise the significance of blood relationship, and realise the eugenic disadvantages of consanguineous unions.

Totemism, in fact, would seem in this matter to have done for the savage races what Christianity and science together have done for the civilised world—and in many respects to have done it more effectively.

Of course, as Mr. Frazer has written, "the dislike of certain marriages must always have existed in the minds of the people, or at least of the leaders, before that dislike, so to say, received legal sanction by being embodied in an exogamous rule."

A Common Belief

Yet how that dislike came into being is by no means easy to comprehend. Maybe, man believed—and this is a belief shared among people far above the state of savagery—that human disobedience to what would seem to be Nature's laws blights and sterilises even their crops and animals.

But this in no way helps one to solve the riddle, for this superstition could only have arisen as a result of the aversion with which such unions were regarded. The aversion itself, therefore, is impossible to account for—unless, perhaps, one is prepared to believe that a proper respect for

The Ordeal by Fire—a Totem Ceremony

(Drawn by Norman Hardy)

Among the tribes of Central Australia the totem ceremonies are many and intricate. The drawing illustrates the fourth phase of the Engwura, or Urumpilla. In this ceremony the young men who aspire to the honour of joining the Urlliara (or Elders) must lie at full length on branches piled above the red-hot ashes of a fire until the old men give them permission to rise. The torture may endure for five to ten minutes

the fundamental and most necessary of all eugenic laws is actually instinctive in the human race.

Australian Phratries

Among the aborigines of Australia, marriage between persons too nearly related is made impossible in consequence of the custom, there almost universal, which causes each individual to belong by birth to one of two main exogamous and intermarrying divisions of his tribe.

These divisions may conveniently be termed "phratries"; they are known usually by the names of animals—Eagle, Hawk and Crow, Crow and White Cockatoo. Now, each phratry contains a number of totem kins—Emu, Wild Cherry, Kangaroo, Dog, Wombat, Frog, Owl; but—except, of course, among the Arunta "nation"—the same totem kin is never found in both phratries.

Thus, since all persons *must* marry out of their own phratries, none *can* marry into his or her own totem kin. Surely a social organisation so ingenious could not have arisen accidentally.

In many parts of North America the same custom prevails; but here matters are complicated considerably by the fact that the phratries are not always two, but sometimes three or even more, in number.

The Mohegans, for example, have three tribal divisions—Wolf, Turtle, and Turkey. In the first the totems are all quadrupeds; in the second, various species of turtle and the yellow eel; in the third they are all birds.

How came the system of exogamy to be instituted? This is a question upon which opinions differ greatly.

According to one theory, man, before ever he could have been brought to recognise a law of exogamy, must have been a member of a tribe—of a commune, that is to say, with its council of elders, its general assembly, and so forth. At first the relation of the sexes was left wholly unregulated. In course of time, however, this state of affairs was recognised as evil; and promiscuity was gradually abolished.

Other authorities—notably Sir Andrew Lang—deny the assertion that man was ever promiscuous. Originally, says Lang, he was, as Darwin supposed, a jealous brute who deliberately expelled his sons from the vicinity of his women folk, in order to secure peace around his own fire circle, and to prevent domestic love feuds. The sons, therefore, were compelled to marry out; in fact, to be exogamous.

As man became more rational and human, he saw, no doubt, the social and economic disadvantages of these family severances. So he decided to allow his sons, even after they had reached man's estate, to continue living among their own kin. But, since the jealousy with which he regarded his own women folk had in no wise abated, he made it a rule that each of his sons must capture a mate from some other herd. Thus the practice of exogamy still survived.

Now, surely, it is more than likely that, in course of time, two groups of men, weary of warring perpetually one against the other for the possession of wives, would agree to make peace, and to give each to the other the right of taking and marrying its women folk.

If this be granted, then it is possible immediately to explain the existence of exogamous, intermarrying phratries, each containing distinctive totem kins.

Result of Alliance

In short, the existence of divisions in a tribe is the result of an alliance between two groups, already exogamous and intermarrying, and not, as on the other theory propounded above, of the dissection of a promiscuous horde.

Perhaps the most extraordinary feature of the social organisation in Australia is the fact that the divisions in one tribe have always recognised equivalents in other tribes. Thus a native, travelling in the country, may expect to be provided with tem-

porary wives by all the various tribes with whom he may sojourn.

His right to these women will be accepted as a matter of course; and, thanks to totem marks and similar signs, he need have no difficulty in ascertaining whether they belong to a division into which he can legally marry, even if he be a thousand miles from his native place and among a tribe whose language is strange to him.

An Amazing State of Affairs

In Australia, in fact, it frequently happens that husband and wife speak different dialects, and continue doing so always. Neither would think for a minute of changing his or her dialect for that of the other. Among some of the tribes of Western Victoria the practice is carried to such an extreme that a man actually is forbidden to marry a woman who speaks the same language as himself.

This amazing state of affairs is probably unique. In North America, at any rate, although a man must marry outside his own clan and outside his own totem, he always marries within the tribe.

Both in America and in Australia descent usually is in the female line—that is to say children belong to the totem clans of their mothers. Still, in many cases this order is reversed; while in a few instances sons inherit the totem of the father, daughters that of the mother.

But these rules are not inflexible. Maybe, owing to war or sickness, the father's clan has become greatly reduced in numbers. If so, and if he give his children not to their mother, but to his sisters, to rear, he may be permitted to endow them with his own totem.

Among some tribes, again—notably those of Bengal—a man is able absolutely to appropriate his wife and her children by means of a system of purchase. A similar custom prevails in the Watubela Islands, off New Guinea.

Here a man may either purchase his wife before marriage, or he may wed her, without making any payment, provided he does not remove her from the custody of her parents, and provided he himself undertakes to work for them.

In the former case, any children that may be born belong to the father; in the latter they belong to the wife's family, and can only be acquired by the father when he has paid the full purchase price.

But quite the most remarkable of all the devices which savages employ to secure for their own totem clans children who would otherwise not belong to them, is that known as the "couvade"—a custom by which a father takes to his bed, and is treated in every respect like an invalid; in fact, as though he were the mother.

This curious practice has been adopted in several districts, and no doubt it serves as a convenient fiction to enable a man to invest himself with the mother's rights, and so hand on his totem to the children.

A similar significance lies at the base of a convention which prevails among the Masai tribe of Central Africa. Here a man always wears feminine apparel for a month after marriage. The Alsatian custom, moreover, by which men dress as women, and women as men, at vintage festivals, may also be a survival of some primitive marriage ceremony.

The Totem Bond

That a man should wish his sons to be of the same totem as himself is only natural. In totem tribes, owing to the law of exogamy, each local group must be broken up into at least two totem clans; and these, should a blood feud arise, would immediately dissolve into their totem elements. Thus, in the event of hostilities, the sons—if they inherited the totem of the mother—would find themselves arrayed against the father.

This, though of course most undesirable, is perfectly natural, for among savage tribes the totem bond is a thousandfold stronger than any bond of blood or kinship known to modern civilised races.

Death's-head Moth in Flight

The Ideal Flying Machines

How Aviators can Improve the Construction of Flying Machines by Studying the Mechanism of Insect Flight

By HAROLD BASTIN

Author of "Insects : Their Life Histories and Habit" &c

THE chief and most obvious difference between a typical insect and any other invertebrate animal that you may care to select is that while the former can fly, the latter cannot. Of course there are some wingless insects; but most of these are clearly related to others that have wings. We are, in fact, justified in believing that the majority of existing insects (possibly all of them) were derived from winged ancestors. How these early insects got their wings is a question that has divided naturalists into two camps. One faction states that what are now wings were once flap like gill-plates, useful for breathing purposes at a time when all insects were aquatic; the other declares that the wings were, from the first, organs of aerial locomotion—that they probably began as parachute like outgrowths from the sides of the body, and in this early stage were serviceable for gliding or scudding, enabling the insect to prolong its leaps. It is a significant fact that there is to-day an Australian spider which is actually equipped with such gliding outgrowths, and uses them in the manner suggested above.

Ideal Flying Machines Artificial

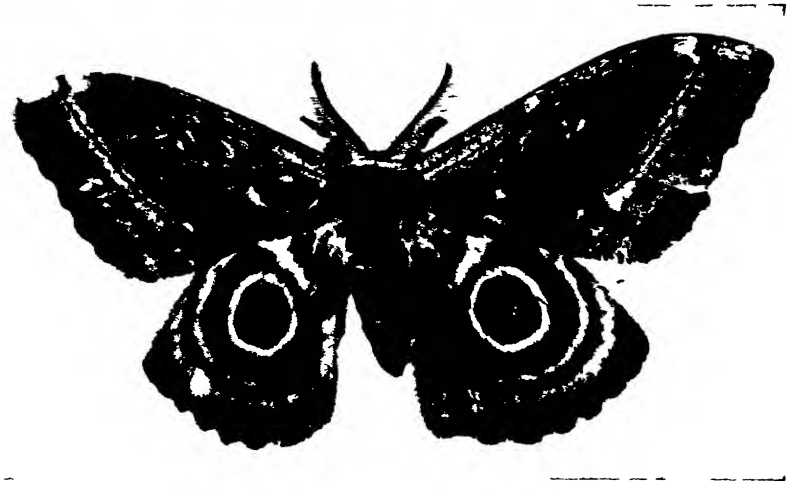
Our present object, however, is not to discuss this difficult question, but to consider briefly the marvellous mechanisms of insect flight. The wings of insects are skinny outgrowths from the second and third segments of the thorax—i.e. the middle part of the body. Their hardness is due to the fact that their substance is permeated (like the rest of the creature's integument) with chitin—a peculiar material, flexible, but very tough and resisting. Each wing consists of two layers in close contact, supported upon a framework of hollow tubes. Many insects have the wings glassy, but in others—notably the butterflies and moths—the whole surface of the wing is densely clothed with minute hairs or scales, which are often brightly coloured, and are always arranged in a pattern characteristic of the species concerned.

The muscles which actuate the insect's wings are very numerous and complicated. Some of them are concerned only with the adjustment of the wings—the spreading, folding, and so on; and with these we need not now deal. The actual flying muscles—those which raise and lower the wings when the insect has launched itself into the air—are of two kinds, viz. direct and indirect. Of the former, the elevator muscle is attached to the wing just *inside* the fulcrum, or point at which the wing is hinged to the body, while the depressor muscle is attached just *outside* this point. The indirect muscles are not attached to the wings at all, but to the inner walls of the flexible thorax. As they alternately contract and relax, the shape of the thorax is altered, and the wings are forced up and down. In dragon-flies, the direct muscles are those which are chiefly concerned in flight. In locusts and their kind the direct and indirect muscles are about equally developed. But in most other kinds of insects the direct muscles are feeble, while the indirect muscles are the largest in the whole body, and constitute the chief motor mechanism of the wings. Readers who may be interested in these mechanical details should visit the Natural History Museum in Cromwell Road, where they will be able to examine some clever models illustrating the manner in which insects fly.

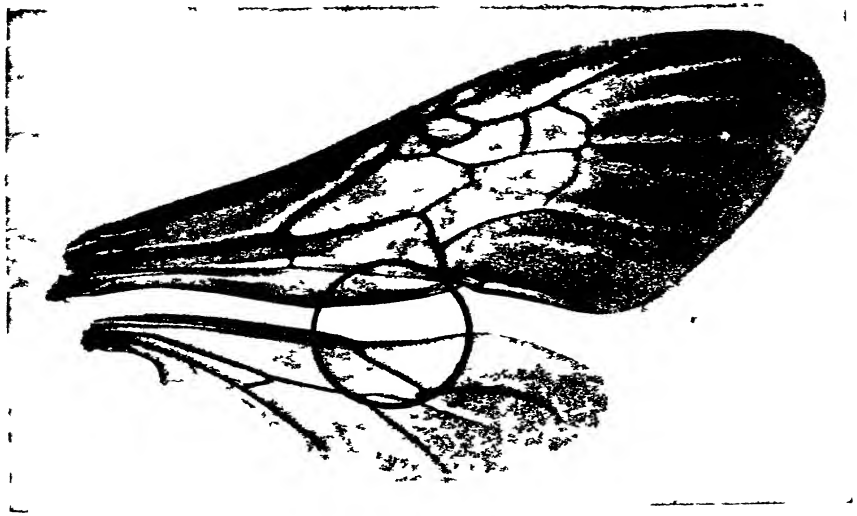
By an elaborate series of experiments, Professor E. J. Marey proved that simple up and down movements are all that is needed for flight in the case of most insects. The front part of the wing is held rigid by strong supports, but the hind part is flexible. Thus, as the wing is raised and lowered, its plane constantly changes; and in accordance with the mechanical law that "an inclined plane which strikes the air has a tendency to move in the direction of

Wing of Death's-head Moth from Beneath

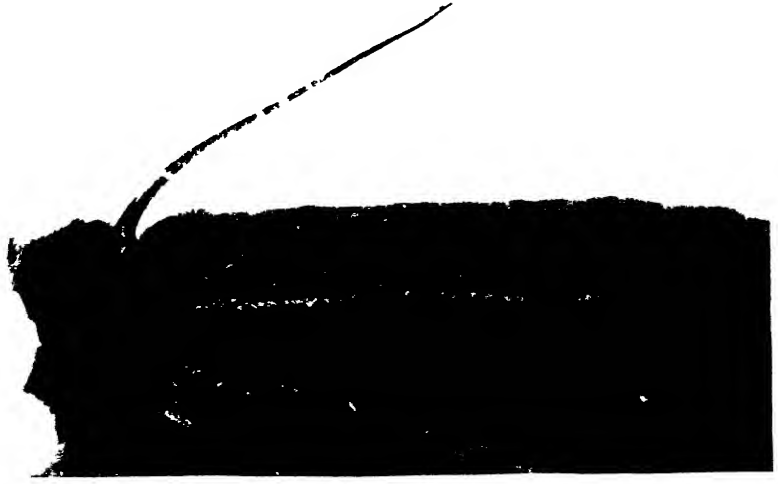
Showing the frenulum and the band-like catch which receives and secures it



1. A Hawk Moth, a Swift Flyer
2. A Gad Fly. The arrow indicates one of the "balancers." These are the dwindled remnants of a second pair of wings
3. A Blue Bottle, a true Fly with only one pair of functional wings; the hind-wings persist only as stalked knobs
4. An African Saturnid, a Slow Flyer



5. Wings of a Humble Bee. Circle shows portion magnified below
6. Observe the row of Hooks on the front margin of Hind-wing, also the corresponding fold in the Fore-wing



Fore-wing of Death's-head Moth, showing "catch"
Hind-wing of Death's-head Moth, showing "frenulum," which fits under the "catch" above

A Biplane

The stag-beetle in flight

Privet Hawk Moth in Flight

Insects with narrow, rapidly-vibrating wings fly faster than those whose wings are broad and slow-flapping

its own inclination," the forward motion of the insect is maintained. The action of the wing has been likened to that of a screw-propeller, which may be considered as an inclined plane whose movement is continuous and always in the same direction. There is one great difference, however, between an insect and a man-made flying machine, namely, that whereas in the former the supporting mechanism and the driving apparatus are unified, in the latter they are separate. No machine that will fly by a movement of its planes, or wings, has so far been invented.

No insect has more than two pairs of wings, while in not a few instances only one pair is used in flight. In the case of the true flies, indeed, the hind-wings persist only as minute stalked knobs, called halteres. That these cannot be directly serviceable in flying is obvious; but they are richly supplied with nerves, and there is some reason for thinking that they assist the insect to maintain its equipoise when in the air—hence their popular name of "balancers." In certain other insects the fore-wings are thick and leathery, and are used to protect the delicate hind-wings when the creature is at rest. This is notably the case with the beetles, whose fore-wings are often hard and shell-like. They are termed wing-cases, or elytra.

Some beetles—e.g. the well-known stag-beetle—hold up their elytra during flight in such a manner that they probably help to support the insect in the air. In fact, such beetles may perhaps be likened to biplanes, whereas others are distinctly of the monoplane type. Among the latter are the great African Goliath beetles, whose elytra are only raised just sufficiently to allow for the spreading of the hind-wings.

In the case of many insects with two pairs of functional wings there is a device whereby the two wings of each side are locked together, and act as one, during flight. For example, if we examine the hind-wing of a bee or a wasp, we shall find a row of minute, upwardly directed hooks on the front margin. These hooks engage, during flight, with a downwardly projecting ridge or fold on the hind margin of the fore-wing, so that both wings rise and fall in co-ordination. In many moths, but not in butterflies, there is a process called the frenulum which projects from the front edge of the hind-wing near to its attachment to the body. This fits under a band-like catch which has its place on the underside of the fore-wing near its base. In the female sex, the frenulum commonly consists of three separate bristles; but in the male it usually

A Monoplane

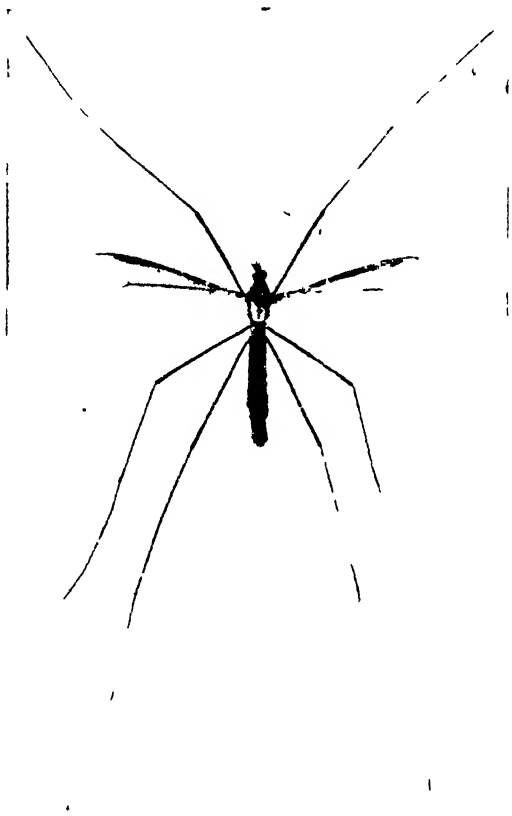
African Goliath beetle in flight

The Dytiscus or Diving Beetle

It lives in ponds and lakes, but at night frequently makes long voyages through the air

takes the form of a single long, curved spine. This, and the catch on the fore-wing, are well seen in the death's-head moth.

These and similar contrivances which are found among insects for co-ordinating the action of the wings seem to indicate that for general purposes one pair of wings is more serviceable than two pairs. It is true that many dragon-flies are exceptionally good fliers; and each of their four wings is capable of independent motion. But we must remember that a dragon-fly, when chasing its prey, must be able to swerve, hover, accelerate or retard its pace, or even dart backwards, in instant response to the movements of its quarry; and it is more than likely that these varied manœuvres could not be effectively carried out if the wings were locked together. But this does not affect the proposition that for straight-forward flight a pair of wings—or four wings acting as a pair—is the ideal mechanism.



The Daddy Longlegs
A well-known type of two-winged fly

The rate at which insects fly, and the rapidity of their wing-vibration, vary greatly. Some butterflies flap their wings only nine times or so per second, whereas it has been estimated that the common house-fly's wings beat the air 330 times during the same interval. In general, insects with narrow, rapidly-vibrating wings move through the air at a higher rate of speed than those whose wings are broad and slow-flapping. This point is well illustrated by the hawk-moths when contrasted with the large Saturnid moths. The former are notorious for their swift and powerful flight, while the latter are slow, and can make little headway against the wind.

Praying Mantids

Ivory Valued at £5,000, brought to the Coast by Collectors

The Last Secrets of the African Forest

Concerning the Okapi and Other Animals
Recently Discovered in the Dark Continent

By SIR H. H. JOHNSTON, G.C.M.G., K.C.B.

THE African continent to a greater extent than any other part of the world (though Tibet, East central Asia, and the Andes region of South America should also receive honourable mention) has preserved, in its deserts, forests, swamps, and mountains, missing links and strange survivals from great faunas which have vanished elsewhere. This continued series of surprises to the intelligent, inquiring European (which began more than 2,000 years ago, when Greek and Roman inquirers expected something new to come out of each expedition into Africa) was, of course, partly owing to the inaccessibility of this continent to the destructive White man from Europe. White men, accustomed to the comfortable conditions of life in Southern Europe and the comparatively easy port-to-port navigation of the Mediterranean or the western Atlantic, were naturally daunted in their African explorations in earlier days. Either they were deterred by the stormy seas which lashed the African coasts—coasts singularly free from penetrating gulfs and far-reaching navigable river-courses - or by the blazing hot, waterless deserts which barred the way to all penetration of the continent north of the equatorial region. Then again, when, in better ships, with the aid of the compass and a greater knowledge of the

science of navigation, they had entered the equatorial zone in the Atlantic or the Indian Oceans, they found their way to the African interior obstructed by dense forests or implacably hostile tribes—tribes, in fact, which, until the invention of machine guns and repeating rifles in the last quarter of the nineteenth century, were virtually unconquerable. Even in southernmost Africa, where there were few forests to bar the way, there were exceptionally stormy seas to be negotiated and desert regions to be traversed, with tse-tse fly constantly ready to attack the horses or the draught-oxen on which the white man relied for the carriage of his supplies.

Little to Reveal

Two-thirds of South America are permeated with easily-navigated rivers, and the indigenous population was never numerous or well armed enough to be a long-standing barrier against exploration. All Asia had been traversed repeatedly by great conquerors, in some cases akin to the European in race and language; and was, until the seventeenth century, on the same general level of civilisation as Europe, as appreciative of wonders in bird, beast, fish, and plant as were our ancestors; and as ready to export its marvels as to import the bullion and the manufactures of Europe. The girdle of exceedingly lofty mountains, with their Arctic climate, or of impassable sandy deserts, as well as the power, the jealousy, the suspicion of China under the Manchu Emperors, did to some extent fend off European inquiry into the natural history of Tibet, Yunnan, and Se-chuan; but at the close of the nineteenth century innermost Asia, together with Andine South America, had little left to reveal to the White man in the way of remarkable unknown beasts, birds, reptiles, fish or insects.

It was not so, however, with Africa. This continent was not completely laid bare to our geographical knowledge until the close of the first decade of the twentieth century, and it was between 1890 and 1912 that some of the most remarkable discoveries were made concerning its fauna.

Two thousand years ago, more or less, the intelligent world of the Mediterranean (that is to say, of Asia Minor, Greece, and Italy) had begun to realise that Africa contained some very remarkable beasts and birds quite foreign (as they thought) to the life of Europe; though had they known anything about the fossil faunas of the lands they governed they would have understood that Africa was merely preserving creatures which had once existed in France, Italy, Germany, Macedonia, Greece, Asia Minor, and Syria. As it was, the Latin conquest of Carthage and the Greek colonisation of Cyrenaica and Egypt revealed by degrees to the early students of natural science who wrote in Latin or in Greek, the existence of the African Elephant, the Giraffe, the Chita, the Spotted Hyena, the Baboon (with a hint, perhaps, of the Chimpanzi or man-like apes derived from Egyptian explorations of Central Africa), the Oryx, Gazelle, Addax and Hartebeest, the Rhinoceros and Hippopotamus, the Guinea Fowl, Crowned Crane, Ostrich, Crocodile, and Python.

The Arab Invasion

The Arab invasion of Africa which followed the promulgation of Islam, revived a knowledge of these strange beasts and birds in the mediæval populations of Europe, which had wellnigh forgotten most of them, but added very little to the revelation of further wonders. Arabs classified nearly all antelopes as "gazelles" or "cattle of the wilderness." They introduced amongst us the word giraffe (though only 200 or 300 years ago) in place of the Latin word camelopard (the Latin word for "leopard" by the by—*leo-pardus*—was really the first name given in the Roman beast shows to the Chita or Hunting-leopard, the true Leopard being known by the Greek term *panthera*, or the Latin *pardus*). But the Arabs may have been

the first people to make any suggestion to the European mind of a striped horse, a "zebra," existing in Tropical Africa, though this concept, together with the name zebra, was first distinctly recorded in European annals by the Portuguese, who met with the animal in Ethiopia, either in its most magnificent form, the Grévy Zebra, or the

uplift to our knowledge of the African fauna after the discoveries of the Portuguese, whose work in this respect is so mixed up with Italian and Spanish research that it is difficult to apportion to each nationality the exact degree of credit for the illustration—chiefly in wonderful tapestries—of African beasts and birds. The

Photo lent by H. H. Tryon, Esq., New York Zoological Society

Grant's Zebra

handsomest of the Burchelline group—Grant's Zebra; and also simultaneously heard of it in Angola.

The Italians of the sixteenth and seventeenth centuries were most industrious (partly incited thereto by the Popes and the Grand Dukes of Tuscany) in collecting information about the African fauna, such as the hippopotamus still lingering in the delta of the Nile (the last hippopotamus killed in Egypt proper was shot by Italians in the year 1658), the birds and beasts of Abyssinia and the Western Congo; but it was probably the Dutch in West Africa and South Africa who gave the greatest

Portuguese in the last half of the fifteenth century made known the large Civet Cat of Tropical Africa (with its powerful perfume) and the Grey Parrot.

The Dutch in the seventeenth century explored a good deal of Senegambia, Liberia, and the Gold Coast. In their descriptions of the Liberian forests they may even have preserved for us records of creatures which have since become extinct. For example, Dapper, writing about 1686, describes a species of wild hog in Liberia which must have resembled very closely the great black forest pig still lingering in Equatorial Africa between the

Photo : Sir H. H. Johnston

The Home of the Okapi in the African Forest

Cameroons and Uganda. In the eighteenth century Dutch writers referred to the existence of various mysterious creatures in the forests of what we should now call Western Congoland; amongst others, the real Unicorn was supposed to be found there. The Unicorn of Roman times was almost certainly the Indian One-horned Rhinoceros, though the term was used by the Romans in reference also to the Two-horned Rhinoceroses of the Northern Sudan. But the Unicorn of the Middle Ages and of the Crusades was, in all probability, a fantastic description of the straight-horned Oryx of either the Beatrix or Beisa species. This antelope, seen sideways, would appear to have but a single horn rising from its forehead very like that of the mythical unicorn, and its slight mane and tufted tail were suggestive of the horse. But the Dutch allusions to a unicorn found in the forests of western Equatorial Africa were more likely allusive to the splendid Bongo Tragelaph of those regions, if, indeed, they were not based on the first glimmer of intelligence regarding the Okapi. In South Africa the Dutch in the eighteenth century (assisted by French, German, and Scottish explorers) not only put us in possession of much definite and decisive information regarding the hippopotamus and the giraffe, but revealed to us the African buffalo (scarcely noted by the Portuguese, though they must have often come into contact with it), the Elephant, Two-horned Rhinoceros, Eland, Quagga, Zebra, Hartebeest, Gnu, Gemsbok, Chakma Baboon, Spotted Hyena, and Brown Hyena, Aardwolf (*Proteles*) and Aardvark (*Orycteropus*), Wart Hog, Bush Pig, several of the smaller Antelopes, Water Buck, Black-backed Jackal, Bontebok and Blesbok, Klip-springer, Hyrax or Dassy, and the Spring-haas or Jumping Hare.

The French, when they began to explore Senegambia seriously at the commencement of the nineteenth century, and after their invasion of Algeria in 1830, added to the list of discoveries several antelopes and tragelaphs, the Sabre-horned Oryx (which was also known to the Romans), the Barbary Stag—the only form of deer now indigenous to Africa—and those two amazing and still very little known baboons, the Mandrill and the Drill, probably first brought home by the French from the coasts of Western Congoland and Gaboon, and of Senegambia. To French explorers and naturalists also we owe the revelation of many beautiful types of *Cercopithecus* Monkeys from the West African forests.

Photo by Sir H. H. Johnston by the New York Zoological Society

The Gelada, or Bare-breasted Baboon

The British had become greatly interested in the zoology of Africa from the close of

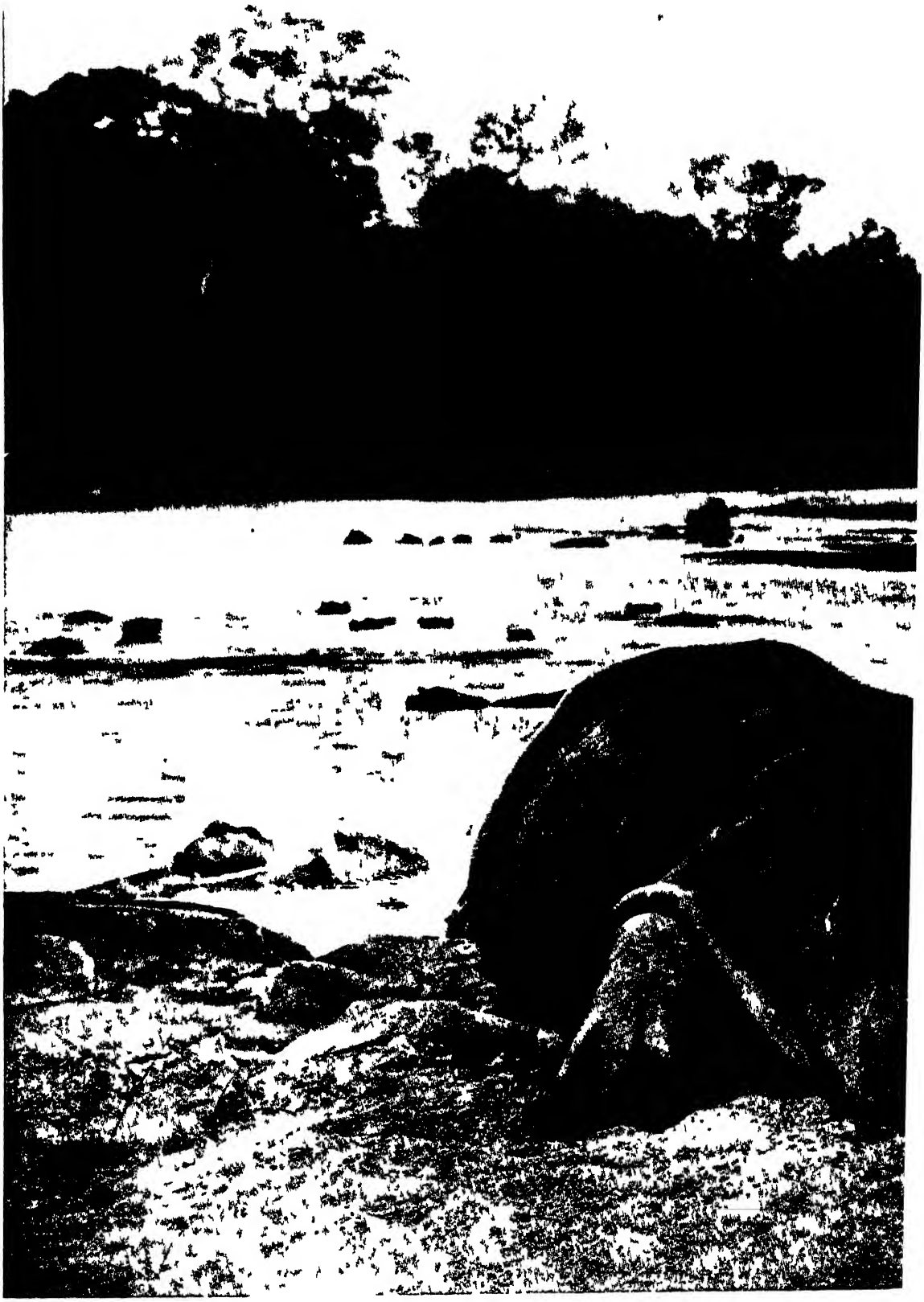
the seventeenth century onwards. In the middle of the eighteenth century several Scotsmen went out to South Africa either to work for the Dutch Government or to explore on their own account, and came back able to give lucid and graphic descriptions of the wonderful beasts of Southern Africa. At the close of the eighteenth century the British had made much headway with the exploration of the Gambia and the Upper Niger. It was, however, really in the nineteenth century that our nation began to take the foremost place in discoveries of the African fauna. The fourteenth Earl of Derby, twice Prime Minister of England, had a great interest in zoology and accumulated a magnificent collection of living animals at Knowsley, near Liverpool. He employed collectors, chiefly on the Upper Gambia River, who revealed to our knowledge several remarkable types of West African antelope, of rodents (including Brush-tailed Porcupines) and birds. Either to them or to Winwood Reade, who followed in their steps, we owe the discovery of the splendid Derbian Eland of Senegambia, which is scarcely distinguishable from the Giant Eland of the Bahr-al-Ghazal, one of the discoveries of the early twentieth century. As soon as the British had displaced the Dutch as the rulers of Cape Colony (in 1806) the exploration of the South African fauna went ahead with wonderful rapidity, chiefly directed by men like William Burchell. Burchell first discriminated between the Quagga, the Mountain Zebra, and the Zebra of the plains, which is known as Burchell's Zebra, and which really includes in its designation the greater number of the zebras of Africa, from Grant's Zebra on the borders of Ethiopia to the zebra of

The Rare Jentinck's Cephalophus of the Liberian Forests

innermost Angola, of Bechuanaland, and South-east Africa. Burchell probably also first distinguished the enormous square-lipped rhinoceros—the so-called White Rhinoceros—from the commoner and somewhat similar type, the Black Rhinoceros, with a pointed, prehensile lip. Other English sportsmen, before and after Burchell, discovered and described the Kudu Tragelaph, the White-striped Eland of South-central Africa, the magnificent Angas' Tragelaph of Zululand, various types of Bush Buck, the marsh-dwelling Situtunga (a northern form of which was discovered by Captain Speke in Uganda in 1861), the Roan Antelope, the Sable Antelope, the Blue Gnu, the Tsessebe or Bastard Hartebeest, the Leehwe Water Buck, the South African Chita or Hunting leopard, the Hunting-dog (*Lycaon*), numerous remarkable rodents and the wonderfully coloured Golden Moles, the Pangolin or Scaled Ant-eater, and the pretty black and white Weasels (*Poecilogale*), the Secretary Bird, and the Stanley Crane.

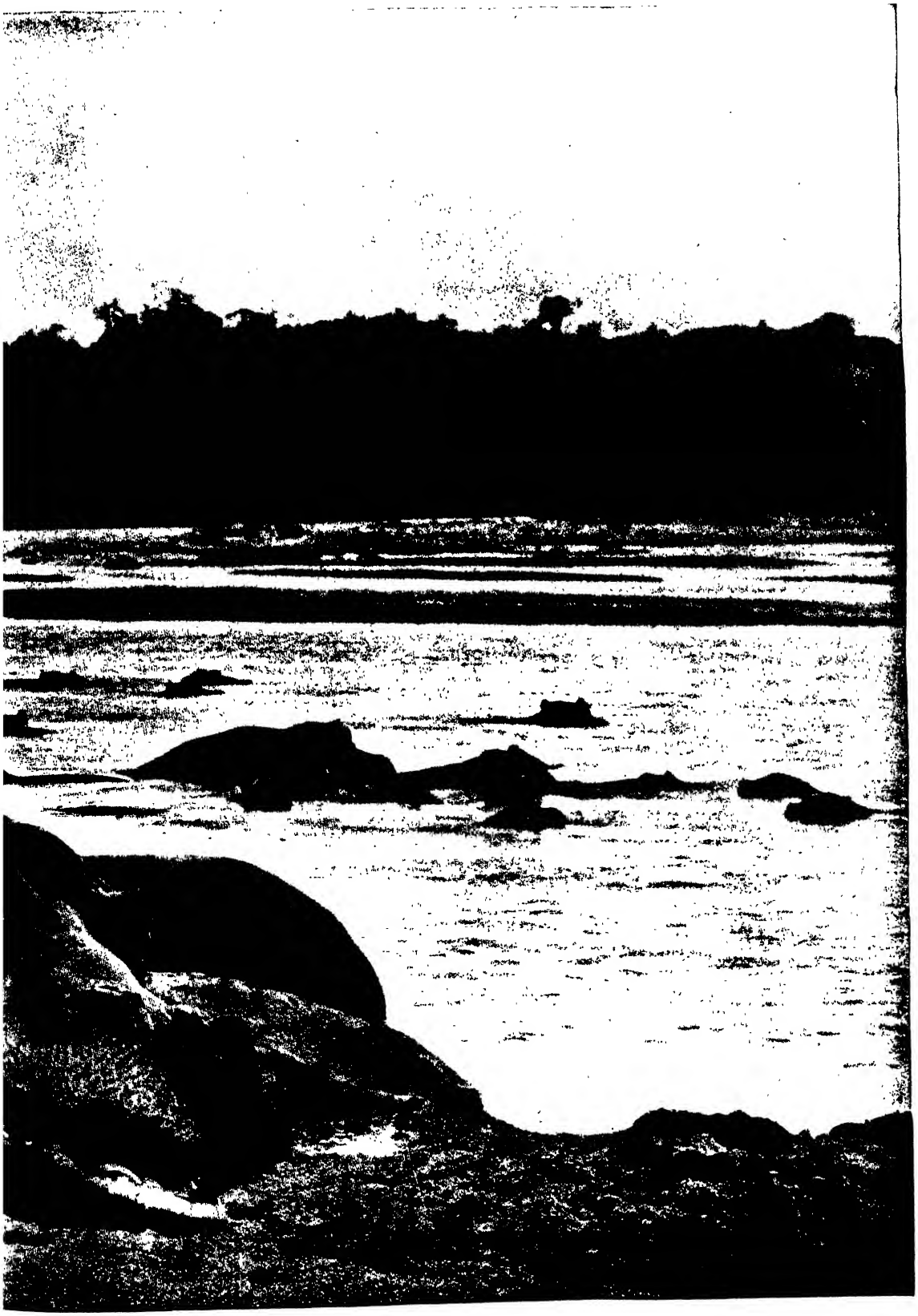
In the forties, fifties, and sixties of the last century the British were making great discoveries in regard to the fauna of the Egyptian Sudan and Ethiopia. It was British energy (notably through Petherick and Samuel Baker) that revealed to the world the wonderful Shoebill Stork (*Balæniceps*) of the Bahr-al-Ghazal (rediscovered by the present writer, in 1900, much farther south on the shores of the Victoria Nyanza), the beautifully coloured Mrs. Gray's Water Buck—handsomest of all the Cobus sub-family—the Gelada or Bare-breasted Baboon of Abyssinia, the magnificent white-mantled, white-plumed Colobus Monkeys of the same region (rediscovered in a still more remarkable form by the present writer on the slopes of Kilimanjaro in 1885). At the same time in those regions, especially Abyssinia and Northern Somaliland, were found many remarkable beasts and birds hitherto only known from the Cape of Good Hope, for there is a remarkable correspondence in fauna between the regions of trans-Zambesia and North-east Africa. The exploration of Somaliland between 1850 and 1900 (specially noteworthy for their discoveries were the brothers James, Mr. Hunter, Colonel E. Swayne, and Mr. E. Lort Phillips) revealed many marvels in mammalian development—the beautiful Soemmering's Gazelle, the still more extraordinary long-necked Gazelles, the Gerenuk and the Dibatag (*Ammodorcas* and *Lithocranius*), the Dwarf Kudu, curious rodents like the Somali form of the *Heterocephalus* (a naked, burrowing, mouse-like animal), and the Crested Rat (*Lophiomys*), little antelopes not easy to classify, like the

The Yellow-backed Cephalophus



WILD LIFE IN EAST AFRICA: WHERE THE HIP

This camera picture shows an extraordinary scene on the Ruaha river, in German East Africa. Some thirty rel
with exceptional clearness the folds of the hide, the bi



OTAMUS DISPORTS HIMSELF IN TROPICAL STREAMS

sport themselves in the river behind the huge fellow resting on the bank in the foreground. The picture shows
the upper and lower jaw, and the huge peg-like teeth

Pygmy Hippo Captured in a Pit in Liberia

Beira Gazelle, Hunter's Antelope, and Swayne's Hartebeest, links between the true Hartebeests, the Gnu, and the Palla Gazelle, the Reticulated Giraffe, and the vulturine Guinea Fowl, with its lovely ultramarine neck colouring. Some of the new antelopes and rodents of the north-eastern Sudan were first described by Swiss or German naturalists (such as Ruppell), and part of the fauna of southern Somaliland and Equatorial East Africa has been simultaneously revealed by Sir John Kirk from the direction of Zanzibar. To Captain Speke we owe not only the discovery of several new beasts in Somaliland, but of the Water Tragelaph of Uganda, and the biggest and handsomest of all the gazelles — Grant's Gazelle. His companion (Grant) also discovered Grant's Zebra.

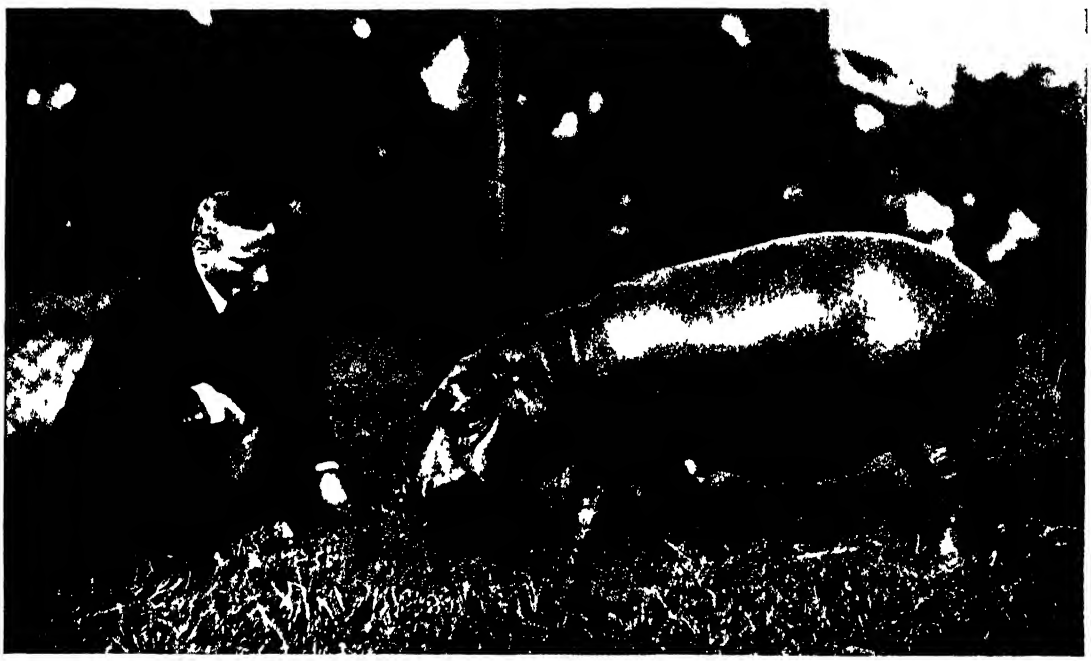
British explorers, or their German colleagues in British pay, made some further discoveries in regard to the fauna of Central Nigeria. Barth recorded the existence of the Lion (absent from the greater part of the Sahara) in the Air Mountains; Bakie revealed the presence of the Manati sirenian in the waters of the Upper Benue; Denham sent home some remarkable Bustards from the region round Lake Chad, and specimens of the Lake Chad Buffalo. But on the whole the revelation of the fauna of Central Nigeria between the Niger River and Lake Chad which were made by the British expeditions of the middle nineteenth century were small. It is only within the last two or three years that the fauna of those regions has been seriously studied, and it may yet yield to our knowledge new beasts or birds.

Swiss and Germans were not only active in the Egyptian Sudan in the second half of the nineteenth century, but in West Africa likewise. A Swiss Professor Büttikofer made on behalf of the Natural History Museums of Holland, the first scientific exploration of Liberia in the seventies and eighties of the nineteenth

Photo Keimers, Hamburg

The Enclosure in which the Captive Pygmy Hippos were kept

century. Already from that small but curiously interesting portion of forested West Africa there had been sent to France specimens of the Pygmy Hippopotamus about 1860, though this animal was not properly studied and fully revealed to us in the living form until two years ago, when all further mystery concerning it was cleared up by the expedition of Captain Hans Schomburgh. Professor Büttikofer But he first obtained and brought to Europe such an amount of material regarding the gorilla as gave us a precise knowledge of the conformation of that ape. In all justice he must be regarded as the discoverer of the gorilla. He also first revealed the most beautiful of all the Tragelaph group, the splendid Bongo Antelope. He made known that most primitive and remarkable of all forms of Guinea Fowl, *Phasidus niger*,



Captain Schomburgh with the First Pygmy Hippo Brought Alive from Liberia

discovered in Liberia some remarkable and large forms of the *Cephalophus* genus of antelopes, besides new monkeys and pangolins.

One of the most remarkable and definite enrichments of our knowledge of the African fauna was due to the work of Paul du Chaillu in the middle of the nineteenth century. This man, of French extraction, but much associated with the United States, went out to the Gaboon as a natural history collector in 1858. It is true that he did not discover the Gorilla, for this largest of all the Anthropoid Apes had first been revealed to science by an American missionary, Dr. Savage, in 1848. which has been rediscovered by Captain Powell Cotton as far east as the Ituri Forest. Many antelopes of the *Cephalophus* genus were added by him to our list of known creatures, together with a large water-frequenting insectivore of otter-like habits, the *Potamogale velox*. The Gaboon and adjoining districts of the Western Congo and the Southern Cameroons is one of the most remarkable portions of Africa for its retention of strange animals. In this region may be found large frogs, apparently with manes of hair, though the hairy tufts are said to be really extravagant developments of skin.

In South-central Africa the last quarter

of the nineteenth century witnessed the discovery or rediscovery of remarkable forms by Mr. F. C. Selous, whose name is attached to several new species of mammals and birds. Sir Alfred Sharpe, then and later, and Captain Richard Crawshay, further extended our knowledge, and added new species of antelope and zebra to our lists. Mr. J. E. Moore made some startling

A Young Okapi

discoveries fifteen to twelve years ago in the waters of Tanganyika, chiefly prawns and jelly-fish, but the importance and mystery of these were lessened by their subsequent rediscovery in the waters of the Victoria Nyanza by Mr. C. W. Hobley. The last mentioned also led the way in the discovery of the fossil and extinct mammals of East-central Africa, showing us that types of rhinoceros and horse have lived and vanished, together with dwarf forms of *Dinotherium*, the elephant with recurved tusks in the lower jaw only.

Perhaps the most sensational discovery of recent years was that of the Okapi in the north-eastern portion of the great Congo Forest.

The Russian explorer, Junker, who had reached from the Bahr-al-Ghazal the north-east limits of the Congo Basin, alluded somewhat vaguely to large striped antelopes to be found in the basin of the Aruwimi River. It is not clear, however, from his description, whether he had seen the skins of the white-striped Bongo Tragelaph or of the Okapi. He himself thought that the strangely-marked skins were of a species allied to the Zebra Antelope of Liberia (one of the remarkable discoveries of Professor Büttikofer). The great explorer Stanley, some time after his return from his Emin Pasha Relief Expedition, in the course of which he marched, first of all explorers, through the dense forests from the Upper Congo to the Albert Nyanza, made a casual mention in his book of the existence of a wild donkey in these forests, which the Pygmies caught in pitfalls. He expatiated on this subject to the present writer when the latter was about to start as Special Commissioner of Uganda in 1899. He also impressed on him the certainty of the existence in the same region of a giant black pig, alleging that he himself had seen this animal on one occasion.

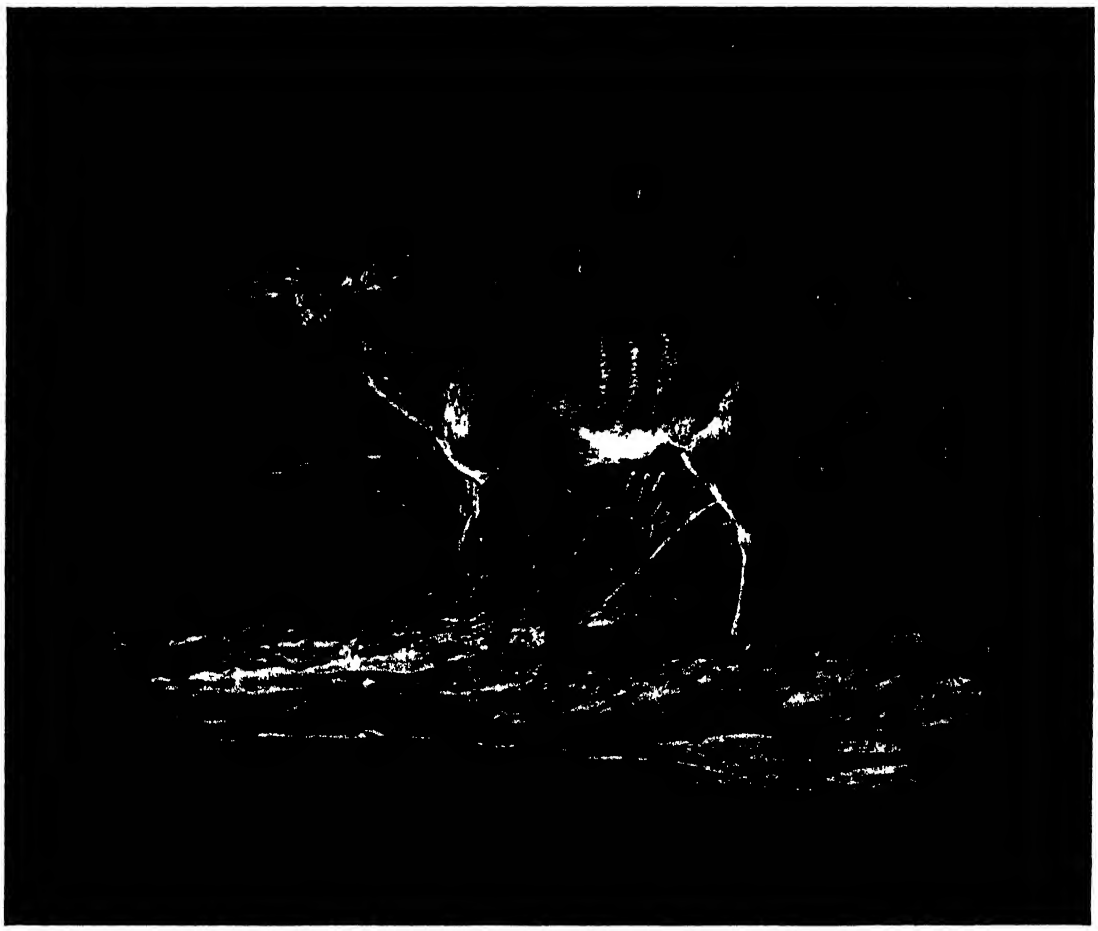
Accordingly, when I reached Uganda, and got into contact with the Congo Pygmies, I questioned them on the subject of the "donkey" they were supposed to catch in pits. They at once expressed by eager nods the truth of the story and described the animal as something like a mule and something like a zebra. Soon afterwards, in 1900, I was able to enter the forest region where they lived, and they endeavoured to guide me to where I might see the Okapi, but as from their description I imagined it to be a kind of horse, I took no interest in its supposed footprints, which were cloven-hoofed like those of an eland. Unable to find the animal, I purchased from the natives of the forest strips of its skin, which I sent

By Sir H. H. Johnston

The Okapi in the Forest

Perhaps the most sensational discovery of recent years was that of the Okapi in the north-eastern portion of the great Congo Forest. At first believed to be a living specimen of the *Helladotherium*, it proved to be an independent genus, which has been named *Ocapia Johnstoni*

to London to the charge of Dr. P. L. Sclater. He recognised that the skin in question belonged to some hitherto undescribed beast, possibly a form of zebra and therefore named the hypothetical type *Equus johnstoni*. Abandoning my search in the forest, however, I applied myself to me, a promise which he redeemed nearly a year afterwards, though, unhappily, he died before they reached me. As soon as I saw the two skulls which he sent, I realised that the creature was absolutely new to science and must be a near relation of the giraffe. I believed it, in fact, to be



Drawn by Sir H. H. Johnston

The Rare Zebra Antelope of Liberia

to the Belgian officials at the nearest Congo States station, who at once confirmed the stories of the pygmies, but opined that the strange striped creature was a type of large antelope, probably hornless. They were well acquainted with its skin and often ate its flesh, which was brought in to them by their native soldiers. The chief of the station (Lieutenant Meura) promised as soon as he could obtain an entire skin and possibly a skull, to forward these specimens a living specimen of the *Helladotherium*, and tentatively naming it "*tigrinum*," sent on the skin and the two skulls to Sir Ray Lankester at the British Museum. Lankester, however, rightly judged that the Okapi (as I named it from the native word) was neither a *Helladotherium* nor even a *Samotherium* (the extinct giraffids to which it is nearest allied), but an independent genus, which he named *Ocapia*. The arrival two years subsequently of an

adult male specimen showed that the male Okapi possesses short, pointed, bony projections or ossicones on the frontal bones, probably with bare, bony tips, which almost answer to the inception of the deer's antlers.

As an interesting coincidence, it may be mentioned that the late George Grenfell, the celebrated Baptist missionary of the Congo, was making simultaneous inquiries as to the existence of the Okapi in another part of the Aruwimi Basin, and virtually discovered the animal there (giving its correct local native name) in 1902. Later Belgian explorations of the Congo Basin showed that the range of the Okapi extended southwards between the Lualaba, the west coast of Tanganyika, to the vicinity of Nyangwe, and westwards between the basins of the Congo and the Mubangi, almost to the lower course of that river, that is to say, near to the hinterland of the Cameroons. It is quite possible that the Okapi may yet be discovered in the eastern hinterland of the Cameroons by that remarkable explorer in natural history, Mr. George L. Bates, who has revealed to us so many strange beasts and birds in the Cameroons interior. He has already sent home proof of the existence in that region of another remarkable beast of the Equatorial African forests—the great Black Forest Pig.

Black Forest Pig

I have mentioned how Sir Henry Stanley not only suggested to me the existence of the Okapi, but further spoke of a very large pig in the same forests. I sought for this pig as diligently as I did for the okapi, but except that I gathered much native confirmation of his story I could obtain no specimen. Strange to say, evidence regarding the Forest Pig was first brought to light in East Africa by Mr. C. W. Hobley, already mentioned. But the first complete specimen of this animal was shot by Captain Meinertzhagen, after whom it is named. Almost simultaneously the Belgians discovered its existence in a slightly different species in the Ituri Forest, and Baron Maurice de Rothschild (together with his assistant, Mr. Harold Hyde Baker, a nephew of the great Sir Samuel, who in his time revealed much of the fauna of the Egyptian Sudan) had found the Forest Pig, probably of the Meinertzhagen type, existing in the Nandi forests of East Africa near the shores of the Victoria Nyanza. The simultaneous discovery by Mr. G. L. Bates carried the range of this remarkable pig from Mount Kenia in East Africa right across the equatorial zone to the Cameroons, so that it is possible that its range may even have extended two or three centuries ago to the forests of Liberia. Captain Powell Cotton had entered the field of faunal discovery in Africa at the close of the nineteenth century, and had made clearly and definitely known to us several remarkable beasts of Abyssinia, such as the Abyssinian Ibex (*Capra walia*) and the curious slender-muzzled dog, *Canis simensis*. He now (succeeding my discovery of the Okapi) proceeded to explore thoroughly the Ituri Forest region, with the result not only of adding to our knowledge of the okapi, but of discovering there the existence of remarkable beasts hitherto only associated with western Equatorial Africa, such as the Water Chevrotain (*Dorcatherium*), and the Pygmy Antelope (*Neotragus*).

The research work of my companions and myself had revealed several new beasts, birds, and fish in Nyasaland; and, assisted by the late W. G. Doggett, I discovered in Uganda, or on the slopes of Mount Ruwenzori, a chimpanzi, new monkeys, remarkable turacos, strange horned chameleons, and the *Balæniceps* Stork, hitherto not known so far south. Other novelties were discovered (including the Tanganyika Gorilla) in the eastern Congo Forest by such leaders as Captain Beringe, the Duke Albrecht of Mecklenburg, the Duke of the Abruzzi, and Dr. Wollaston.

Other New Beasts

By permission of the National Railways of Mexico

Statue of Cuitlahuac, the Last of the Aztecs

The City of the Gods

Concerning the Mysterious Capital of a Forgotten pre-Aztec Empire in Mexico

By J. A. BRENDON, B.A.

WHEN the Spaniards conquered Mexico, it was not a new world that they brought within their dominion, but a very old world.

Even in those far off days the country was a land of ruins. It still is a land of ruins, amid which dimly can be traced the footsteps of unknown, forgotten people—people who had attained a degree of civilisation even higher, perhaps, than that which Cortes found in the Aztec Empire and in the Court of Montezuma, the proud monarch whom he humbled and laid low.

Regarding that civilisation we know nothing—save that it existed. And this we know because in Mexico there are the ruins of cities as wonderful in construction and design as any that can be found in Greece, Italy, and the East; the ruins of temples, palaces, and tombs no whit less splendid than the gorgeous structures which adorn the banks of the Nile; and pyramids that will bear comparison even with the massive monuments on the Egyptian deserts.

Some twenty-seven miles east of the city of Mexico lies the village of San Juan Teotihuacan, near which can be seen traces

of a city covering an area of four square miles. A part of the wall still stands. It is two hundred feet thick and thirty-two feet high.

Whence came the people who built it, or whither they went, nobody knows.

The belief that, in the days of its splendour, the city was, as its name implies, a "City of the Gods," is supported by the presence of numerous pyramids, great and small, which lie scattered over the plain. Of these pyramids the two largest are dedicated respectively to the sun and the moon; and the former, which is 682 feet long at its base, and 180 feet high, is neither dissimilar in design from, nor less massive than, some of the pyramids of Egypt.

The indications of Eastern influences on the architecture of the prehistoric cities of the New World are so markedly pronounced that one can but suppose the early civilisation of Mexico to have been of Oriental origin; and this theory is strengthened by a similarity in beliefs, manners, customs, and institutions, which, in the light of the meagre information available, appears also to have existed.

Near to Puebla stands the great temple of Cholula, the most famous of the Mexican pyramids. This, according to legend, was designed by a family of giants who aspired to raise a building to the clouds, but the gods, displeased with their presumption, sent fires from heaven on the pyramid, and compelled the work to be abandoned.

Photo by permission of the National Railways of Mexico

The Ancient Pyramid of the Sun at Teotihuacan

The parallel between this legend and the Hebrew account of the Tower of Babel surely is too striking to be regarded as purely accidental; and this is but one of innumerable beliefs which are shared in common by the people of Mexico and the races of the East.

The notion that at some time in its history the earth was submerged by a deluge is as

prevalent in the New World as in the Old. The Aztecs believe that two persons escaped the deluge, a man named Cox-cox, and his wife. Their heads are commonly depicted in ancient paintings, together with a boat floating on the waters, and a dove.

The goddess Cioacoatl, again, whom the Aztecs describe as "our lady and mother," "the first goddess who brought forth," "by whom sin came into the world," is usually depicted with a serpent near her, and her story in many respects resembles that of the Eve of the Hebrew and Syrian nations.

A large majority of the present inhabitants of Mexico are descendants of Indian tribes who were found there by the Spanish conquerors; but they bear in appearance a closer resemblance to the Malay races of Asia than to the American Indians. This, surely, is also significant, and points strongly to the conclusion that their ancestors were of Oriental origin.

It seems probable that the early inhabitants of Mexico were connected in some way with the Tartar tribes. How or when it is impossible to say; the migrations must have occurred at some very remote period in the world's history—perhaps in the days before the sea had divided the continents of America and Asia.

At Palenque in Yucatan there are the remains of a palace and a holy city; and here, as in numerous other places, the buildings are distinguished by strange

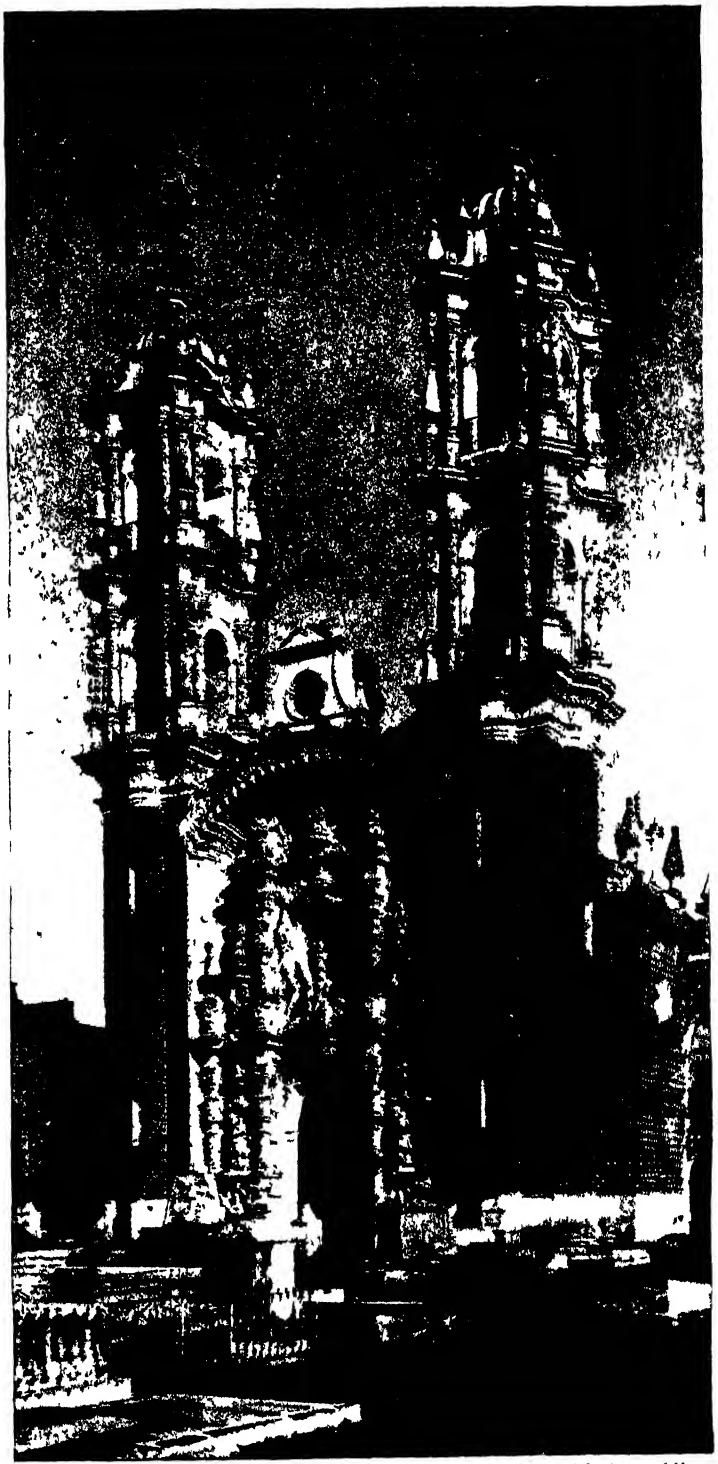


Photo Kahlo, Mexico City, by permission of the National Railways of Mexico

A Modern Mexican Church at Tlaxcala

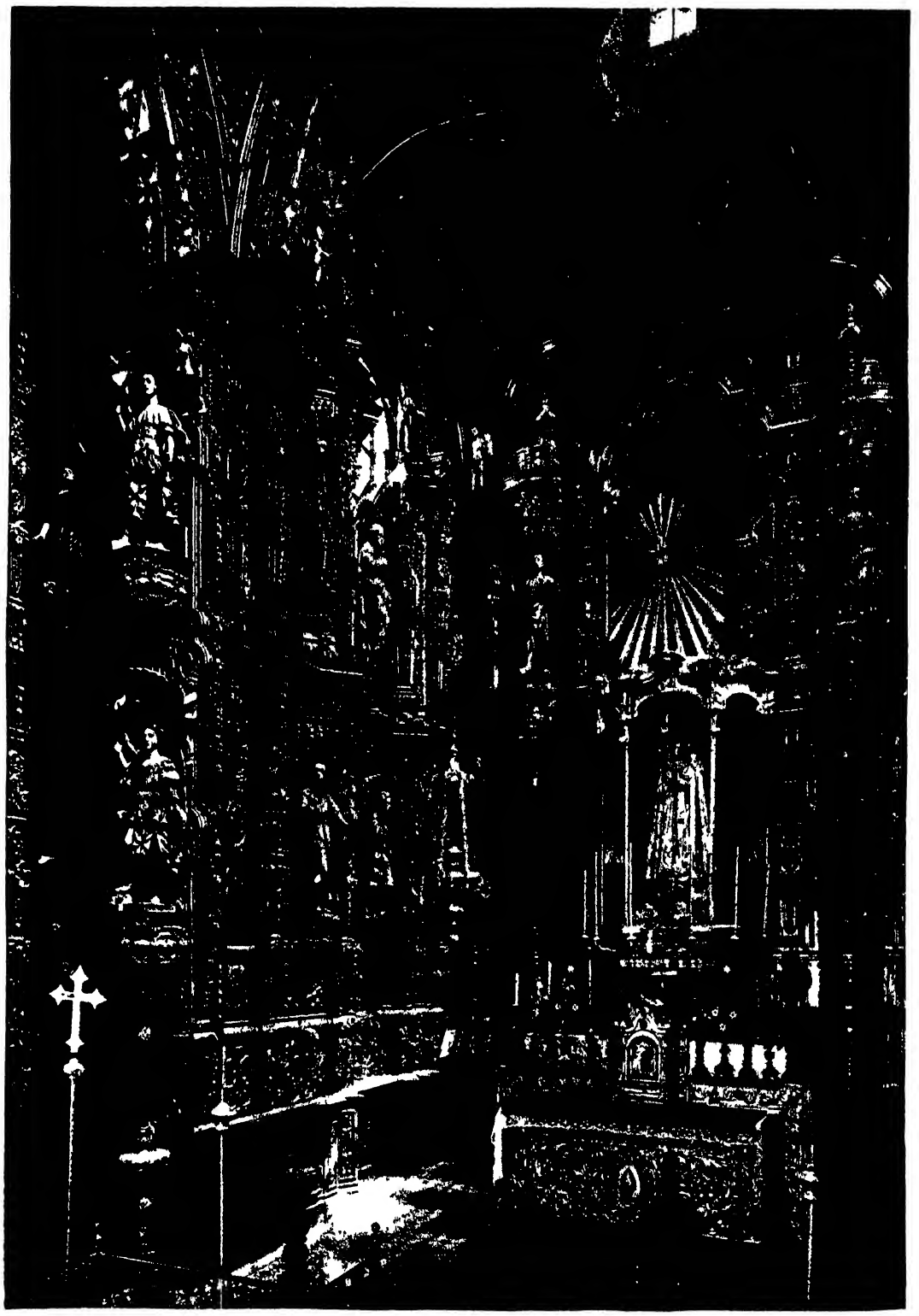


Photo Kahlo, Mexico City, by permission of the National Railways of Mexico

Where Christianity First Gained Foothold on the American Continent

When he invaded Mexico, Cortes was opposed by the warlike Tlaxcaltecs. On being defeated they helped the invader to crush their ancient enemy the Aztec Empire. In their capital, Tlaxcala, where this fine church stands, the first Christian church on the American continent was erected

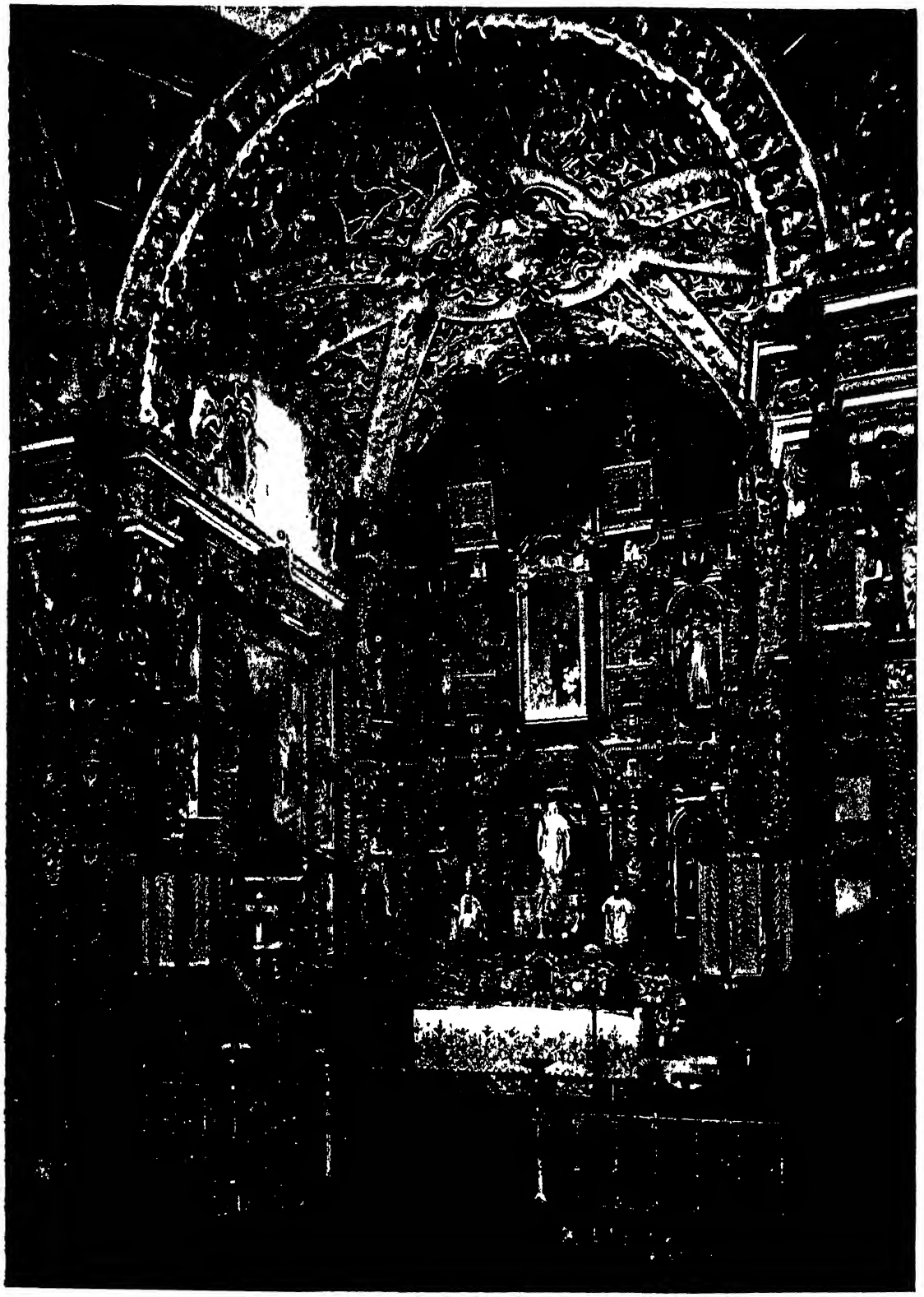


Photo Kahlo Mexico City by permission of the National Railways of Mexico

Interior of the Church of San Francisco Acatepec at Cholula

In days so remote that even the Aztecs could give no account of them, there was built at Cholula a mighty temple, the Mexican "Tower of Babel," in honour of the god Quetzalcoatl. Now his temple is deserted, and the Cholulans worship in this beautiful church

hieroglyphical writings which have marked Eastern characteristics. But whether the early civilisation of Mexico was older or of more recent date than that of Egypt and Hindustan, no one can say. There are no historical records to help us, and very few legends; whilst the Spanish priests, when first they arrived in the country, in fanatical frenzy against an idolatrous people, destroyed all the picture writings of the Aztecs upon which they were able to lay hands.

One can only gaze, therefore, at the many ruined cities which extend from the Valley of Mexico right down to the remotest corners of Yucatàn, and vainly ask them to yield up their secrets. Those massive walls tell nothing; they merely stand there, the sole and silent witnesses of a forgotten greatness

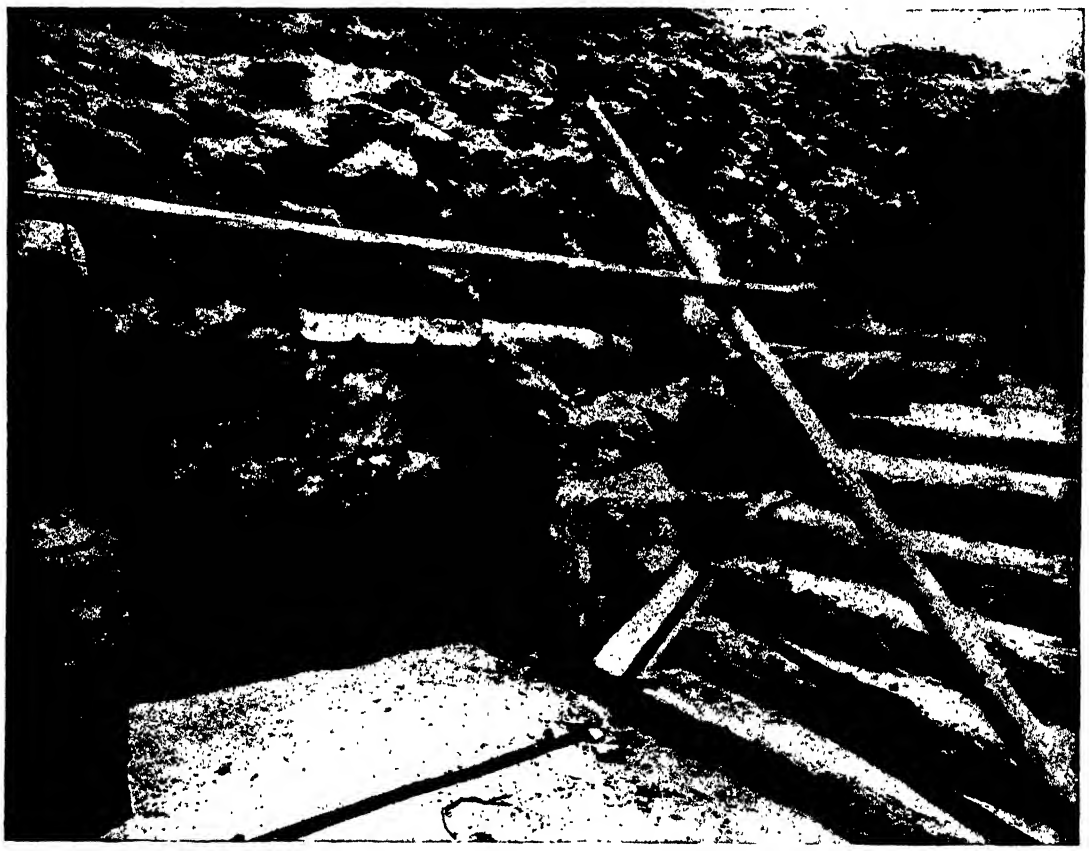


Photo by permission of the National Railways of Mexico

Excavations at the Pyramid of the Sun

Mural paintings and other relics of amazing interest have been laid bare

Prairie Marmot Outside its Burrow

Subterranean Dwellers

Creatures that have Forestalled Man in Excavating Underground "Tubes"

By W. S. BERRIDGE, F.Z.S.

IT has been suggested that, owing to the rapid growth of tube and underground railways in the world's chief cities, before many generations are past we shall have amidst us a race of human beings of strange and abnormal appearance who will live almost entirely underground, and only occasionally see daylight and breathe untainted air.

Whether such a state of affairs will ever come about, or is merely the fancy of a fertile brain, we must leave time to decide.

In the animal kingdom, however, we have, at least, been forestalled in this respect, for many species have selected for their mode of life a subterranean existence, either partially or wholly, being driven to do so for various reasons—in some cases through undue persecution from their enemies, and in others as a better means of obtaining a food supply. With most animals, however, it is the comparative safety and quietude afforded by a burrow, or underground dwelling, that induces them to resort to such a situation, and this choice, or lack of choice, as the case may be, is shared by many kinds of living creatures, including mammals, birds, reptiles, and even fish.

One of the most familiar of the mammals that excavate burrows is the rabbit; and it speaks well for the security of their domain when one considers that, in spite of incessant persecution, or, should one more charitably say, thinning out of their numbers, they continue to increase at such a rate as to be a positive pest in some countries.

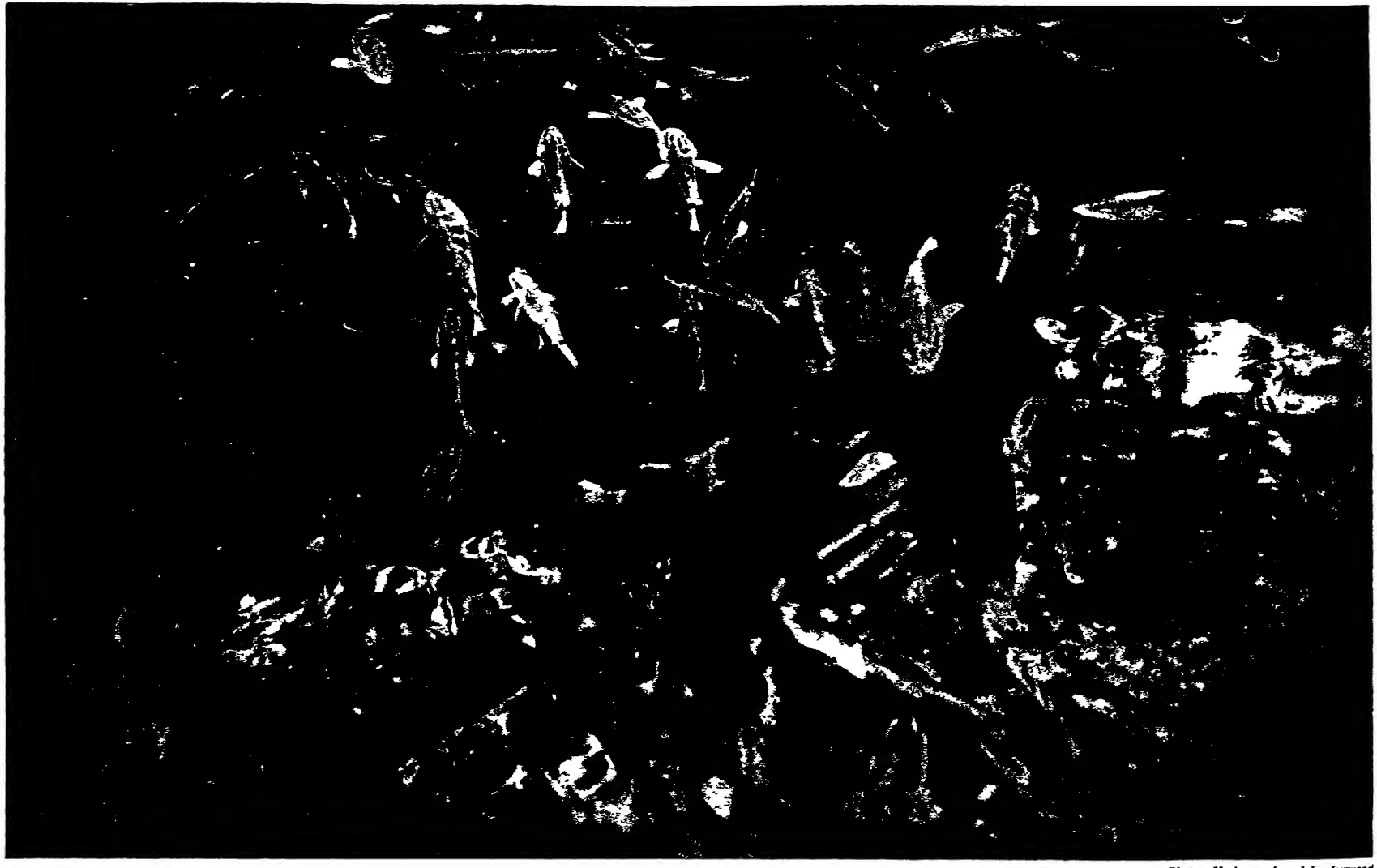


Photo Underwood and Underwood

Fish in the Devil's Hole, Bermuda

The rat is another familiar example, although not always subterranean in its mode of life, that is justly looked upon with disfavour, and which selects as its impregnable fastness the most inaccessible situations, ranging from the basements of our houses to the sewers thereunder; and to a lesser degree the more humble mouse is also responsible for a great deal of discomfort through its artfulness in evading ejection by living in situations that afford it a tolerably safe shelter. But in order to find a true subterranean dweller we must go into the fields, and, if fortune favours, we shall come across a number of loosely piled cones of earth, which, should they be situated upon a favourite tennis-court or cricket pitch, are likely to damp one's ardour for the further study of natural history.

These are the work of the mole, a creature some six or eight inches in length, and possessing very powerful fore feet armed with strong claws, which enable it to burrow through the earth with considerable speed and agility. Its fur is of the most beautiful texture, and to the touch suggests plush; whilst in colour it is usually of a greyish-brown. A very remarkable feature about its fur is that, no matter in what direction it is brushed, it does not become ruffled, so that during its excavations the creature's coat does not become impregnated with loose earth that might happen to fall upon it. There is a popular belief, retained even at the present day, that moles have no eyes; but this is quite a mistake, for if the fur on the sides of the head be parted, two minute but very bright eyes are easily discernible. In spite of the fact that no external ears are visible, yet, nevertheless, they are extremely quick of hearing, owing to the high development of the internal auditory organs. Moles are probably one of the most voracious feeders of all animals, considering their size, and many score of worms and grubs are devoured during a day to satisfy their needs. That its large appetite is not merely the result of gluttony is clearly proved by the fact that if food is withheld for about ten hours the creature dies from starvation. They are great fighters, and frequently kill one another, the victor usually making a meal of its victim. In spite of their subterranean habits moles are quite capable

Drawn by J. S. Chatterton

Kingfisher's Nest

The tunnel to the nest is shown in section

of swimming, and many instances are recorded of their crossing streams.

Although they have a wide distribution, being found as far afield as Japan, yet, curiously enough, they do not occur in Ireland. Some curious animals that assume a likeness to the mole, both in general appearance and in their subterranean habits, are the mole-rats, of which our illustration depicts Zech's mole-rat, a native of Northern Nigeria.

These animals, however, differ from the true moles in a very important feature, namely in possessing large and projecting incisor teeth, which are, in themselves, sufficient to prove that the creatures belong to the rodent order, and not to the insectivora, to which latter group the true moles belong. Furthermore, we find that the mole-rats feed upon roots and bulbs, instead of upon worms and insects.

Important Differences

Their burrows are of considerable length, and usually made at a depth of eighteen inches below the surface. Dr. J. Anderson, in writing of the great mole-rat, states that their burrows may extend for a distance of as much as forty yards.

The borings leading to their food store are, however, usually of greater depth than the others, descending to as much as four feet, and at the bottom of which a supply of bulbs and roots is kept for future use. In colour Zech's mole-rat is mostly of a creamy white, and in measurement attains to a length of about six inches, whilst the eyes are so small as to be difficult to discern.

Another group of animals that excavate burrows in which they spend a great part of their time are the marmots. Of these the best known is the prairie-marmot, prairie-dog, or barking-squirrel, as it is variously called, a denizen of the plains east of the Rocky Mountains, where they congregate in immense numbers; their burrows being known to be distributed over as much as two hundred acres of land, and spoken of as "dog-towns."

These little animals are about twelve inches in length, exclusive of the tail, which adds some four or five inches to the total, and are of an extremely sociable disposition. Each burrow, which, by the way, does not communicate with that of any other in the neighbourhood, is the home of some ten or twelve inmates. The entrance to the burrow is surmounted by a cone-shaped mound, which not only serves as a point of vantage for an outlook station, but more important still, keeps the rains from flooding their homes. These mounds are usually about two feet in height, with a circumference of five or six feet. The marmots are very alert, and ever on the look out to guard against danger, and on the least sign of anything suspicious will quickly retire to their fastnesses.

They feed principally upon the roots of grasses, and in the more northern parts of their habitat keep entirely to their burrows during the cold weather. The name of "dog" they receive is on account of the bark-like cry they utter when alarmed.

Of the other species of marmots a familiar example is the alpine marmot, which is much larger than the foregoing species. It grows to a length of about twenty inches. Central Asia is the home of several other kinds, some of which are much appreciated by the inhabitants as an item of their diet.

Somewhat similar in appearance to the marmots are a group of animals known as sousliks, which they also resemble as regards habits, although it is said that the latter vary their diet of roots and berries by partaking of mice, small birds and their eggs.

The Sousliks

Although one usually associates the squirrels as living a free and unfettered life amongst the trees, yet certain species, known as ground-squirrels or chipmunks, not only spend the greater part of their time upon the ground, but, furthermore, make their homes in a hole they have

Some Subterranean Dwellers

1. Burrowing owl
2. Viscacha
4. Zech's mole-rat
5. Nest of Trap-door spider
6. Common mole

excavated in the ground, or else in some suitable situation in the shelter of a stump of a tree.

The North American Chipmunk

Probably the best known of these animals is the North American chipmunk, a tiny little creature only a few inches in length. Although very squirrel-like in appearance, these animals differ from the true squirrels by having cheek-pouches, which serve them in good stead as receptacles for carrying their winter store of food to its destination. They feed largely upon nuts and beech-mast, supplemented at times by a diet of the larvæ of insects; and owing to their being by no means of a hardy nature, they retire to their winter quarters as early as November, and do not come forth again until the more genial weather of March or April approaches.

For their winter use the chipmunk collects together a great amount of food, and the naturalists, Audubon and Bachman, in their writings of this species, record that in a hole tenanted by four chipmunks the nest itself contained a gill of corn, and that in the galleries leading from it were found about a quart of nuts, a peck of acorns, nearly two quarts of buckwheat, and a small amount of Indian corn and grass seeds.

As there still remains to be mentioned certain birds and reptiles in connection with an underground existence, we must conclude our remarks on the subterranean-dwelling mammals by a brief mention of that remarkable looking creature, known as the viscacha, a heavily-built animal about two feet in length.

Their range extends from Buenos Ayres to the northern parts of Patagonia, where they live in families of some twenty or thirty individuals. The warrens are known as "viscachera," and frequently extend over two hundred square feet of ground.

The animals are entirely nocturnal in their habits, and feed upon grasses, roots, and other vegetable matter.

Their burrows form a considerable source of danger to horsemen owing to their undermining the ground, and consequently they are killed by man whenever the opportunity arises, whilst other foes that they have to contend against are the puma and the pampas-fox—or, as it is sometimes called, Azara's dog.

The viscachas have a curious habit of decorating the entrances around their burrows with all manner of materials, such as stones, old bones, thistle stalks, and other *objets d'art.* In reference to this trait it may be of interest to repeat the story told by Darwin of a gentleman who dropped his watch one night when out riding, but, returning the next morning and carefully searching around the entrances of the viscacha's burrows on the line of his route, was ultimately rewarded by finding it again.

Other mammals could be mentioned in connection with their underground habits, did space permit, but we must pass on to the birds that make subterranean homes for themselves. The best known amongst these is possibly the pretty little burrowing owl, which only attains to a height of some nine inches when adult. Although these birds generally excavate the burrows on their own account, yet not infrequently they billet themselves, unasked, in the homes of prairie-marmots and the viscachas; and it is said that owing to the uncleanly habits of the birds, the latter animals are soon forced to leave their homes and take up fresh quarters.

The Kingfisher

Two other birds that make small burrows just inside the entrances of those of the viscacha are the minerva—a bird somewhat like our wheatear—and a kind of swallow. Mention must also be made of our British kingfisher, that excavates a long tunnel-like hole in a bank wherein to lay its eggs and rear a family, and of the sand-martin, whose habits in this respect are very similar.

Burrowing Snake

Many kinds of reptiles also spend the greater part of their time under ground, and the sand-burrowing habits of certain lizards is familiar to all. More remarkable instances, however, are those of the burrowing snakes, that have the appearance of large worms rather than that of snakes, and the curious horned frogs or *Ceratophrys*, that have the habit of burying their bodies in the earth with only the top of their head and eyes showing, in which position they remain motionless for hours on the look-out for their prey.

The fish that resort to burrowing habits are few in number but remarkable in habits and structure; and of these the lung-fish represented by the African *Protopterus*, the American *Lepidosiren* and the Australian *Ceratodus* are familiar examples. The latter is at the present day only found in the Burnett and Mary Rivers of Queensland, but during the Secondary Epoch its habitat included Europe, India, North America, and South Africa.

The African lung-fish has the curious habit of making a kind of nest, or cocoon, in the bed of a stream at the approach of the dry season, wherein it remains in a torpid condition until the return of the waters.

During the period of inactivity, the fish breathes entirely by means of lungs, but at normal times it uses both lungs and gills. A short time ago, one of these fish arrived at the London Zoological Gardens encased in a hard sun-baked clod of earth. This was placed in a tank of water, and in spite of its long journey from Africa, the fish quickly emerged from its retreat and renewed its life as an aquatic creature.

African Lung Fish

Burrow containing Cocoon of African Lung Fish

Electric Discharge Similar in Character to St. Elmo's Fire

This spark was photographed while travelling from the point of a wire to a copper disc

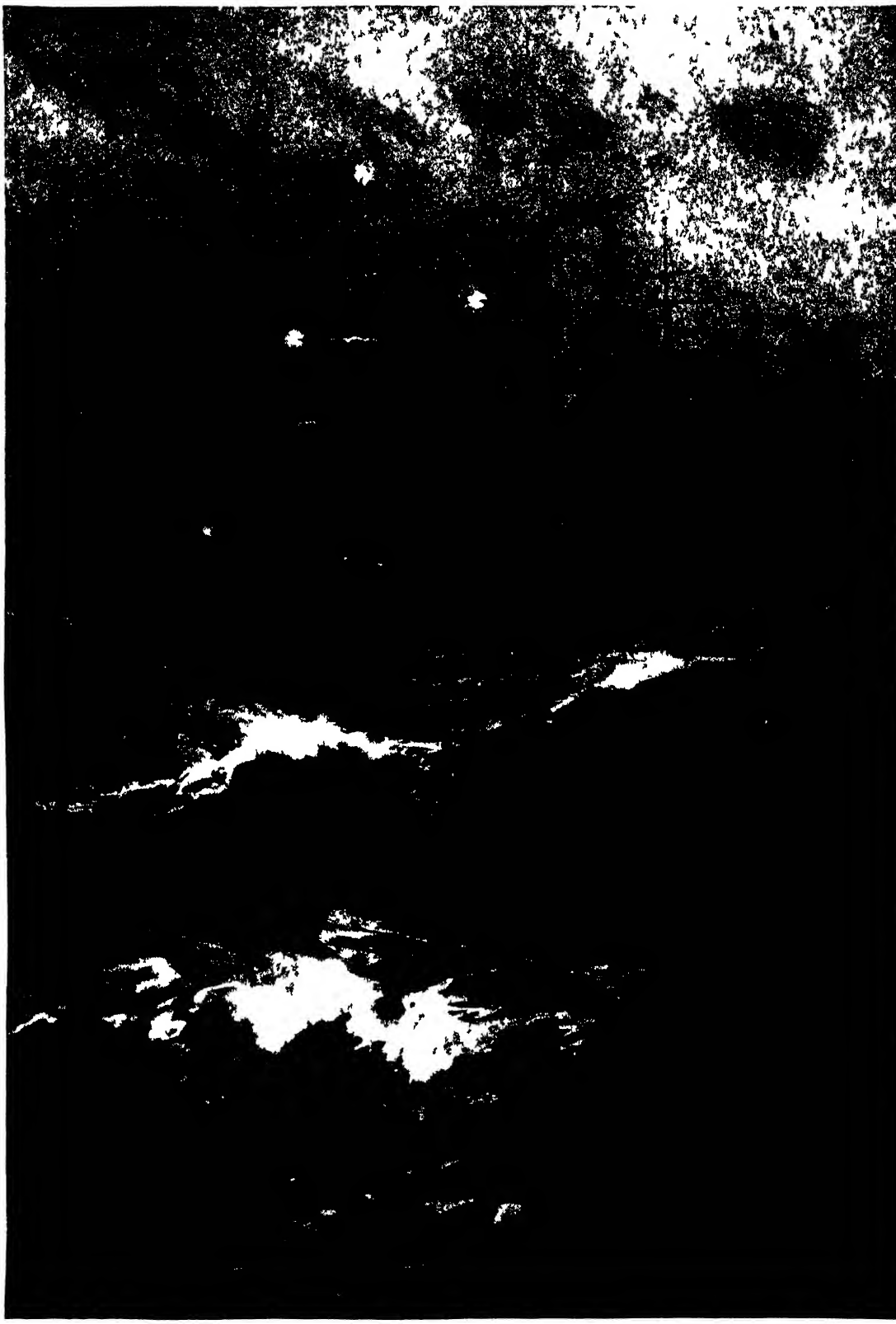
St. Elmo's Fire

An Aerial Electrical Wonder that has Given Rise to Countless Superstitions

By REGINALD C. FRY

A CRACKLING, fan-shaped flame, brilliant and continuous in its luminosity, burning steadily high in the air on some lofty structure, was a thing of awe and dread to superstitious folk in the past years. Many have been the tales told of this weird-showing natural phenomenon, and countless the dread omens the hissing fire of St. Elmo has given birth to in days when simple villagers—and other classes as well—sought to read the future from the signs of Nature's workings.

And certainly in some instances its appearance has been singular almost beyond belief. What could be more awesome, and to superstitious beings, more full of dread import, than a whole army of infantrymen marching steadily, bent on their grim calling in the stillness of night, with rifles shouldered and bayonets fixed, and then suddenly for each man's glittering bayonet point to blaze with this strange sizzling, atmospheric fire, so that, where a moment before marched an unseen armed force,



St. Elmo's Fire

Sometimes at the masthead tapering far above, at others at the spar-ends, the hissing and brilliant St. Elmo's fire dances, the flames seeming to rise from the ship's projecting points

Nature changed it in a second of time into a procession of soldiery bearing flaming torches. Like some long serpent, blazing with myriad lights in a galaxy of hissing fires, regiments have been known to march across wide, low-lying plains, while overhead the sombre masses of storm-cloud only served to heighten the dread spectacle of this wonder of the atmosphere. Again, men's finger-tips and their hair, and the manes of horses bestrode by them have been seen, time and again, to flare with the unearthly glow of St. Elmo's fire.

Photograph copyright by William Hope Hodgson

Sailors Repairing Damage after a Storm

The writer has often, while aboard ship in southern latitudes, when ominous thunder-clouds have darkened an angry sea, watched a black bulk of nimbus loom over the vessel's masts blotting out the star-lit sky as a pall. Then, sometimes at the masthead tapering far above, at others at the spar-ends, suddenly the hissing and brilliant St. Elmo's fire would dance, looking like flaming brushes to the wonder-filled crew below, the flames seeming to rise from the ship's projecting points.

When one has seen this strange, uncanny-looking electrical discharge gleaming brilliantly under a lowering, storm-swept sky, and accompanied by the sharply-sounding crackling noise, it is not to be wondered at that in the past superstitious seamen (and where will one find men so prone to supernatural beliefs as deep-water sailors ?) were wont to invoke the dancing light of St. Elmo's fire as the visible sign of their patron saint's presence and the promise of his guardianship during storms; for it is to St. Elmo they look as their protector.

Though sometimes observed at great elevations—in the snowy fastnesses of the Swiss Alps and above the rock-bound canyons of Colorado, for example—St. Elmo's fire is mostly seen at low levels during the winter months. It is frequently observed during and immediately after snowstorms. The colour and appearance of this strange atmospherical fire are found to differ enormously, in accordance with the nature of the electrical cloud hovering above the earthward and opposite pole of attraction; the predominating colour of the flames being red in a positive and blue in a negative discharge.

But however strange the display may seem its cause is simple. When a highly-charged cloud of electricity, composed entirely of either positive or negative force, approaches a prominent pointed object in contact with earth, and therefore having both kinds of electricity within its body, all the energy of the opposite pole of magnetism is attracted to the cloud overhead, and the two forces combine, not in a lightning flash, but continuously in a brilliant glow, just as, when a lightning conductor is working imperfectly, the tip of the rod is seen to be illumined with a perceptible halo. This hissing fire is Nature's " brush " discharge.

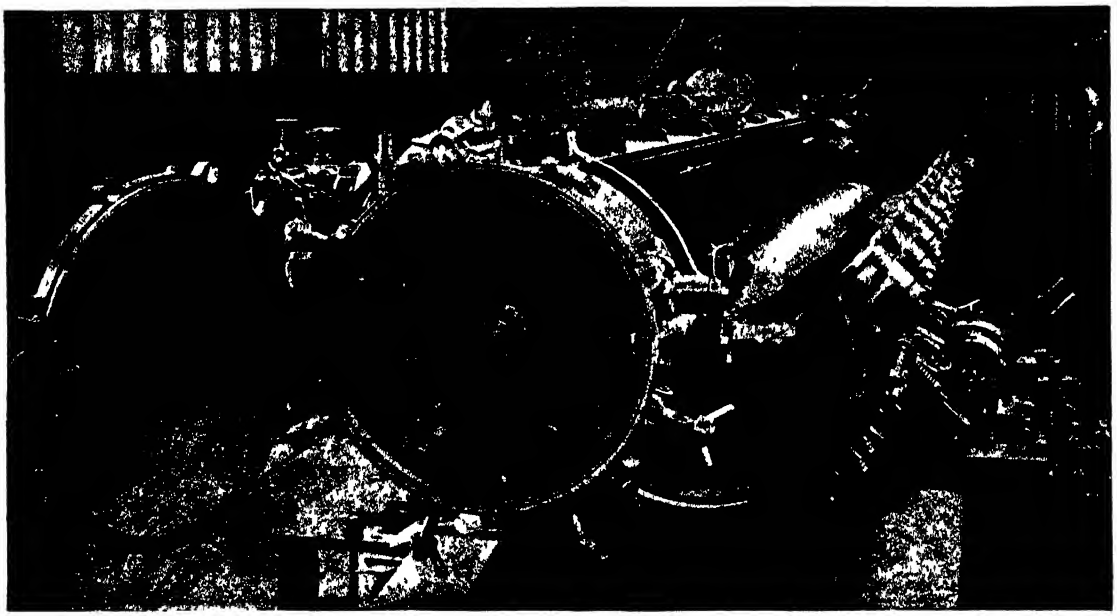


Photo by permission of Sir W. G. Armstrong, Whitworth & Co., Ltd.

Side-loading Torpedo Tube

The Deadly Fish of War

The Wonders of the Modern Torpedo

By HORACE C. DAVIS

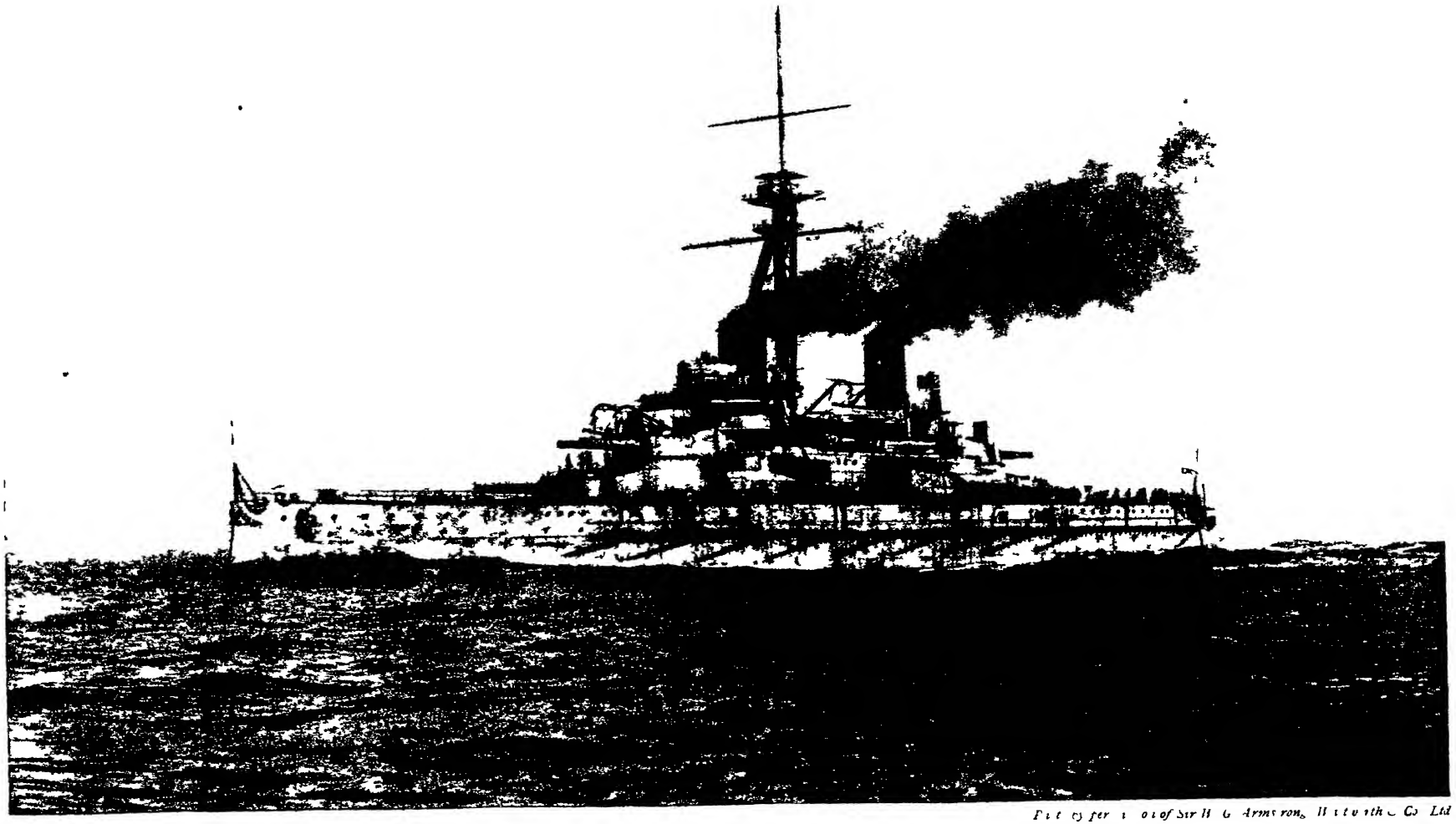
THE deadly steel fish that brought into being the torpedo boats, and destroyers, now forming the spear-head of our Fleet, is one of the most sinister weapons that the brain of man ever conceived for the slaying of his fellows, and to-day the weapon has been so improved that the modern 21-inch automobile torpedo can, for awhile, maintain a speed through the water equal to that of a fast railway train.

In this country we use the Whitehead type, and in all modern craft, and in all the super-Dreadnoughts, the torpedo is 21 inches in diameter, and has a bursting charge of approximately 250 lb. of wet gun-cotton.

The method of construction is in the hands of several well-known and important firms, in addition to the Whitehead Company, and all the improvements that are added to these death-dealing machines from time to time are naturally very jealously-guarded secrets.

For testing we have several "ranges," the most important being situated between the wild mountains of Scotland in the deep still waters of a loch, which is 7,000 yards in length and has only been opened for this purpose a few years.

To give a simple description of the modern torpedo it is as well to commence by examining, firstly, the striker in the nose of the weapon: this is a steel pin which, on striking its victim, is forced in and ignites a charge of fulminate of mercury, which in turn explodes the gun-cotton in the war-head. This pin, right up to the time of firing, is fitted with a safety device, and even when this is removed there is a



Photograph by permission of Sir W. G. Armstrong, Whitworth & Co. Ltd.

The Speed Trial of a Battleship

A battleship has only her speed and the adroitness and aim of the gunners behind her anti-torpedo guns to protect her against her mosquito attackers. It is true that she has steel nets, attached to long booms, that are fixed to her sides and flung out to form a screen round her, but these are only effective when the vessel is at anchor

further ingenious arrangement to safeguard the firing ship against premature explosion. This device consists of a miniature steel propeller which is screwed into a cut-thread in the striking pin. Immediately the weapon enters the water and commences to run away, the water forced against this miniature propeller causes it to revolve, and by so doing it automatically unscrews itself until it is revolving upon the smooth portion of the pin; in this way the torpedo would not be able to explode if it accidentally struck floating wreckage in close proximity to the firing vessel.

Safety Device

The war-head, the next object to be examined, is packed tight with square blocks of gun-cotton, and is made of steel, and is screwed on to the body of the projectile.

We now come to the centre section which is the compressed-air chamber. Contained in this "flask" is air, pumped in until it is compressed to 150 atmospheres, and from here the air is carried through pipes to the reducing valve, and then to the heater. This heater was first fitted in 1907, and caused the torpedo, by adding 100 per cent. to the pressure available, to advance its speed and add to its deadliness. The heater is quite a compact little device, takes up less than three inches of the length of the torpedo, and weighs little over 12 lb.

Conveniently near the combustion chamber is placed the fuel pot. The oil fuel is led to this by a small pipe and projected under pressure through a nozzle into the chamber, where it mingles, after the starting valve has been opened, with the air passing through. When once lighted this mixture burns so long as air and fuel are supplied, so that the working of the little device is wholly automatic and prevents the engines freezing up when working in extremely cold weather.

To give an illuminating example of what this improvement means it may be mentioned that with experiments carried out in an 18-inch torpedo, the weapon was found to be travelling—at a distance of 1,000 yards from where it entered the water—at thirty-five knots when cold air was used, and at forty-three knots with heated atmosphere. At a range of 4,000 yards the cold-air torpedo was only able to proceed at about eighteen knots' speed, yet the hot-air weapon at the same distance could still do thirty knots.

Next, examining the engines, we find a small chamber fitted with the most delicate and beautiful little machines that ever delighted the eye of an engineer. They are started by a striker that is attached to the top of the projectile, and which, in turn, trips against a catch in the torpedo tube, so that the engines commence to work as the steel fish is forced into the sea. These machines drive the twin propellers attached to the stern and which revolve in opposite directions. The exhausted air, after being used by the engines, is forced out through the hollow propeller shaft and rises in a stream of bubbles that clearly indicate in calm weather the course of the weapon. To keep the projectile on its course, and attend to the steering, the gyroscope is brought into action, and this ingenious and intricate device will keep the torpedo dead true to its course even if it is temporarily turned by waves or currents.

There are other devices crowded into the projectile, and one of the most important of these sets the depth of the run, so that the torpedo can speed on its errand at any depth that the torpedo man requires.

Having examined this instrument of death, costing £500 for the 18-inch weapon with a correspondingly higher price for the improved 21-inch projectile, it is next necessary to examine the method of launching the torpedo from the ship. Two means are employed, viz. by compressed air in the larger vessels and the submarines, and by a small charge of gun-

Launching the Torpedo

cotton in the torpedo boats, destroyers, and small cruisers. All the launching tubes in the battleships are placed well below the surface, so that it is impossible for the shell from the enemy to explode the torpedo in its tube. In these torpedo "flats," far below the surface, are great immovable tubes which with their fittings are, of course, double the weight of those mounted marksmen of the fleet are some of the finest shots in the world. They have a competition and prize of their own that is equivalent to the Gunlayers' Tests, and, needless to add, the rivalry is very keen. The torpedo tube is loaded by opening the breech and sliding in the lithe steel fish. Next the powder charge is put in a chamber attached to the breech, and the electrical

Photo Stephen Crabb

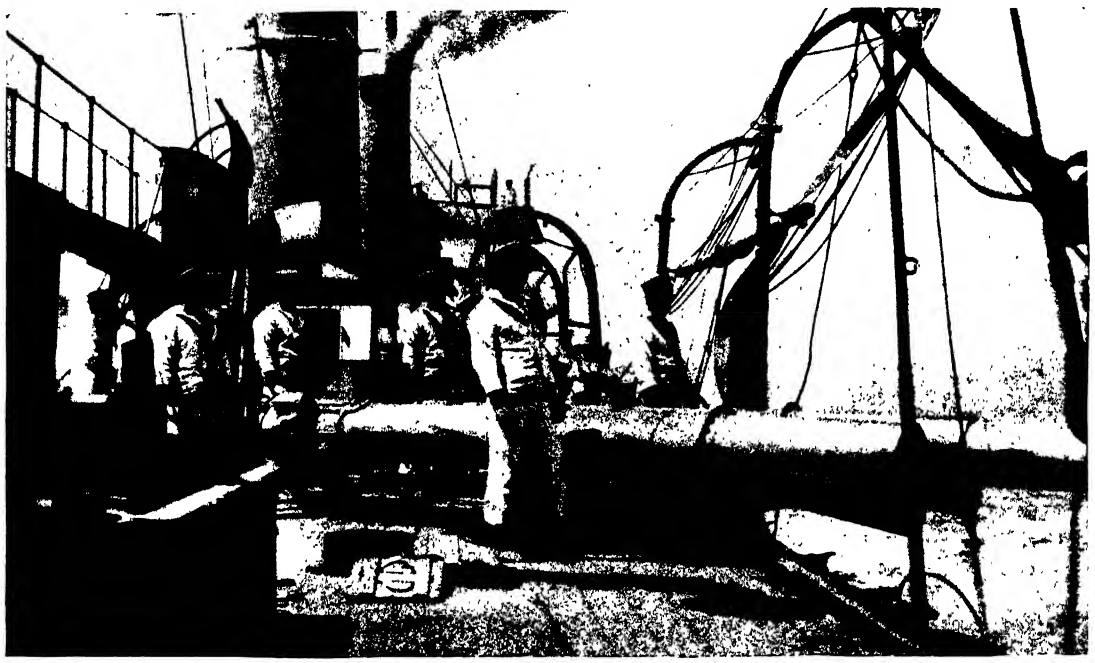
One of the Deadliest of Modern Weapons

A 21-inch Whitehead ("Hardcastle") Torpedo being hoisted aboard a modern super-Dreadnought, which contains three such monsters, 2 submerged (broadside) and 1 submerged (stem). It is fired by hot air and fitted with gyrostats

and in the destroyers. The torpedo is placed in the tube, the breech closed, and the tube flooded. At the signal from above, the torpedo, water and all, are forced out by a fierce blast of compressed air. In the destroyers the tube is placed on deck, and is, of course, in no way protected from the shells of the enemy, so that if by a lucky shot a projectile should strike a loaded tube, and explode the torpedo, there would be a sudden and violent end to the career of that torpedo craft.

But the risk is taken and the torpedo circuits connected. The gunner sitting astride the tube, by means of a handle and spur-gearing, turns the tube on the turntable, makes a rapid calculation (aided by his sighting gear) of his speed and the speed of the target, and pulls the trigger. This sounds very simple, but means a tremendous amount of study on the part of the clean-shaven, sturdy individual astride the tube, who incidentally during that training has cost his countrymen £300 on wages, etc. But let it be remembered that these torpedo craft, in time of trouble, are called upon

to strike home when the nights are black and the rollers are washing the fo'c'stle; a time when the enemy is but a blacker smudge against the heaving horizon. Then keen gunners will be on the alert behind anti-torpedo guns, and equally alert figures will work the searchlights, that at any moment may pick up the track of the attacking destroyer, and turn on a glare of light that temporarily blinds the torpedo people and makes good practice difficult.

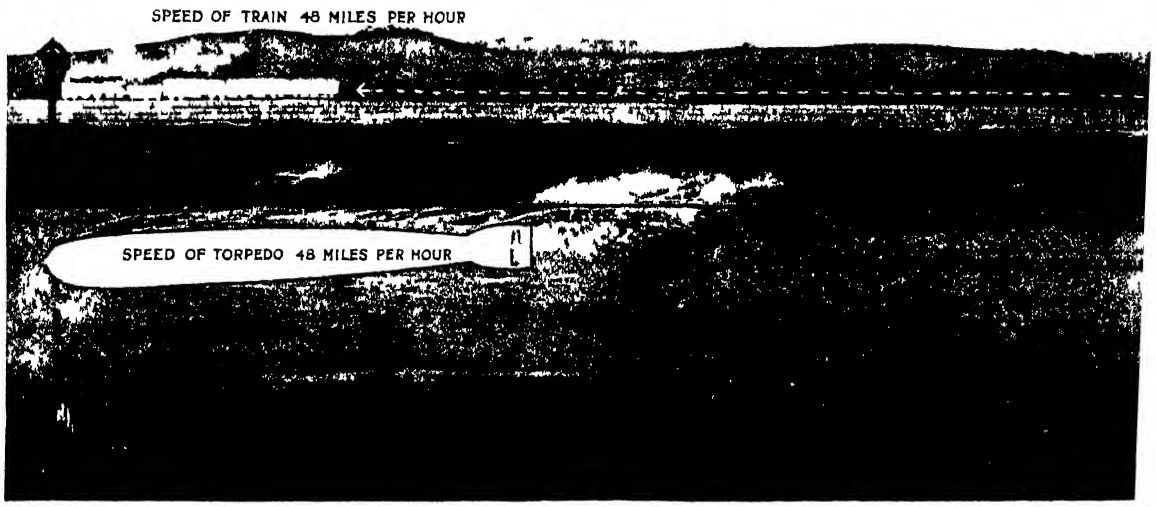


Torpedo Practice in Australian Waters

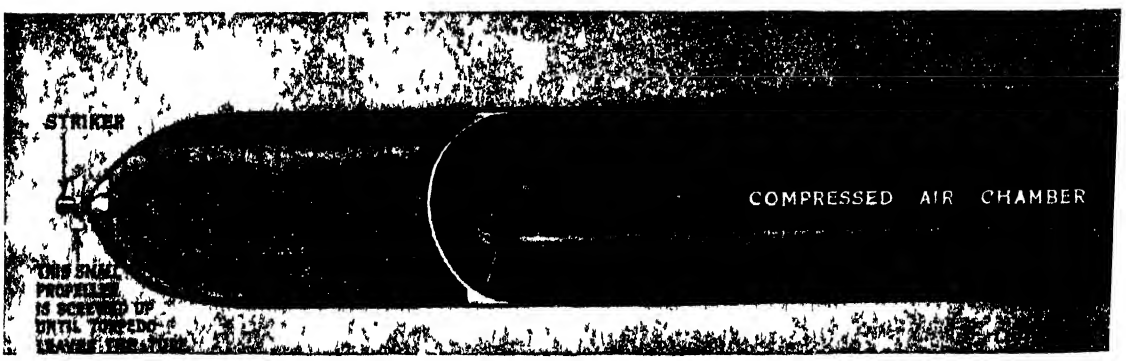
The torpedo man knows that in the tube he has a projectile that, once fairly "home," will put the finest battleship afloat *hors de combat*

Nevertheless the torpedo man knows that in the tube upon which he sits he has a projectile that, once fairly "home," will put the finest battleship afloat *hors de combat;* and further, there is the comforting thought which the lessons learned even before the Great War clearly demonstrated, that the modern destroyer is not sent to Davy Jones's locker by the first shell that splits open her frail skin. During the Russo-Japanese War, for instance, one Japanese destroyer was struck by over a score of Russian projectiles and still remained afloat. Moreover, it was noteworthy, that by making a series of extremely successful raids upon the Russian Port Arthur fleet, the torpedoes did so much harm that this weapon may have been said to have turned the scale in favour of Japan from the very beginning, and, though in after battles it added little to the laurels it earned in the early days of the Port Arthur fighting, nevertheless, after the desperate battle of Tsushima, the attacks of the Japanese flotillas caused several of the badly shattered Russian ships to surrender, and gave the remaining stalwarts the final blow that sent them and their brave crews to the bottom.

In the Balkan War the torpedo again proved its power, and though the Bulgarians had but small and feeble torpedo craft compared with those of the great sea nations, they were able to get "home" a torpedo which so badly holed the Turkish cruiser *Hamidieh*, that she went into Constantinople with her bows under water and in a sinking

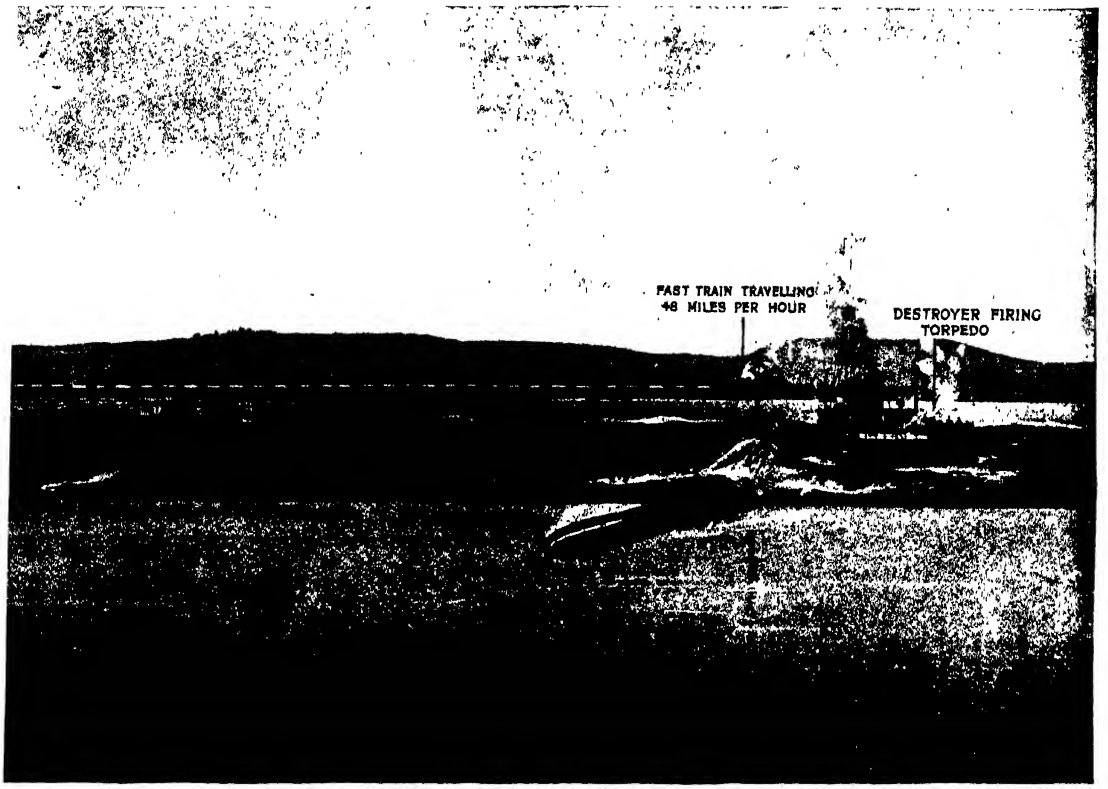


THE HIGH SPEED OF A MODERN TORPEDO—A MODERN TOR



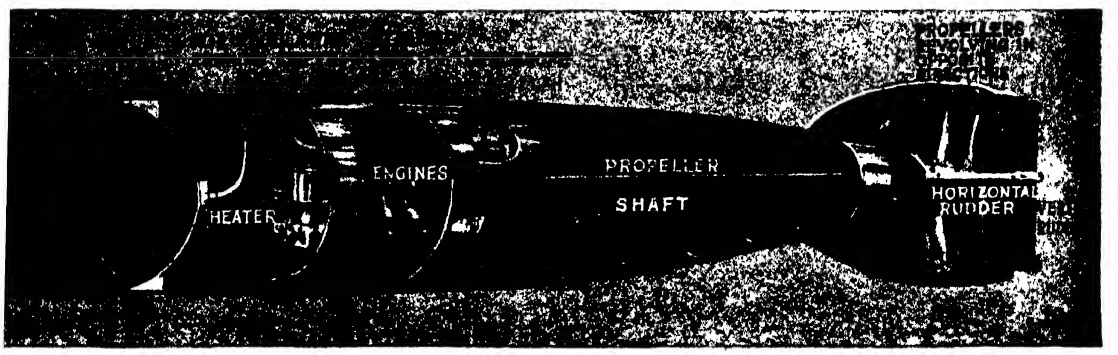
THE DEADLY FISH OF WAR—SECTION OF TI

The torpedo is discharged from a tube on the deck of a destroyer, just enough power being given to push the l heated compressed air charged to a pressure of 1,500 lb to the square inch, and revolve two propellers in oppo comes into work and keeps the projectile true to her course and depth with wonderful accuracy



Drawn by G. H. Davis

EDO TRAVELLING AT THE SAME RATE AS A FAST TRAIN



Drawn by G. H. Davis

MODERN HIGH-SPEED, LONG-RANGE TORPEDO

eel fish into the water. On its passage down the tube a catch sets in motion the engines, which are driven by irections. The torpedo man having previously set the depth at which the torpedo is to proceed, the gyroscope next rovision of a "heater" has recently made a remarkable difference to the range and speed of the torpedo

condition. Several critical weeks passed before she was again fit to go to sea. The Greek torpedo craft also successfully attacked one of Turkey's oldest fighting ships, sending her to the bottom. In both these cases the attackers received no damage themselves.

The data concerning the value of torpedo craft in naval war collected on these occasions were naturally of the greatest interest to all the Powers, more especially to Great Britain and to Germany, which were so soon to test the theories arising therefrom on each other's fleets.

The Torpedo's Power

In Germany the torpedo is looked upon as a weapon just as deadly as the gun, and accordingly the new German torpedoes carry an enormous bursting charge. Power and speed are sacrificed to give the weapon terrific smashing ability when it does get a fair hit. The German torpedo craft are regarded as the lance-head of the Kaiser's navy.

Years will have passed after the conclusion of peace between the belligerents of 1914 and subsequent years before all the naval problems arising therefrom are settled to the satisfaction of the experts.

There is one drawback, common to all torpedoes, and that is if they miss their mark they will career away until their valves open, and they sink with all their delicate and intricate machinery.

But a few years ago an inventor attempted to remedy this defect. He had noticed that a torpedo, on entering the wash of a ship, had its nose temporarily forced off its course by the boiling sea, and again, in leaving the disturbed area the tail was turned in a like manner. Profiting by this experiment he invented a small device (weighing about 1 lb.) which causes the torpedo to lose control of the gyroscope on entering the wash of the attacked ship just at the moment when its nose is violently twisted out of its course; this jambs the rudder so that the projectile, proceeding at forty miles an hour, continues to career round and round in a large circle until its energy is expended, and, if other ships are following the attacked vessel, it is highly probable that one of them would receive the deadly nose against her side.

The Element of Luck

The battleship on her part has only her speed, the adroitness and aim of her gunners behind her 4-inch and 6-inch anti-torpedo weapons, and the fickle god, Luck, to protect her against her mosquito attackers. It is true that she is provided with steel nets that are attached to long booms fixed to her sides and slung out to form a screen around her. This is only effective when the vessel is at anchor, for the simple reason that, when steaming, the nets are swept towards the surface, and the vulnerable lower hull still remains unprotected, and a torpedo, even if it did not sink a modern super-Dreadnought, nevertheless would be quite certain to give her a bad shaking and perhaps throw her machinery out of alignment, and put a vast and valuable fighting unit temporarily out of action at a time when her services were urgently required.

The Physician of the Soil

A Pinch of Earth as a Battlefield

By N. F. WATSON

SIR ALMROTH WRIGHT, our foremost bacteriologist, has told us that in the future the sick and ailing man will be asked by his doctor, "What is your microbe?" The time will come when the powers that be, concerned for the food supply of the world, will appoint physicians for the soil. These, confronted by fields, sterile or of declining fertility, will ask the farmer, "What are your bacteria?" The greatest hive of industry in the entire universe is a pinch of cultivated soil, but it is also the most terrific battleground. There is magic unthinkable in a grain of earth. Tiny though it is, it contains normally 100,000 micro-organisms, committed by destiny to the service of man. Such a grain, polluted, may comprise over 7,000,000 bacteria—Greater London's population in one grain of soil.

But that minute speck of earth is a battlefield, grim and sanguinary. It is the meeting-place of the first of husbandmen—and their foes. The bulk of the bacteria in the soil are the benignant servants of man, fixing the atmospheric nitrogen upon which all vegetation feeds; opposed to them are certain mysterious organisms which, in this limited world, roam free and unfettered, seeking whom they may devour. They slay and batten upon the benevolent bacteria; the struggle for existence in one grain of soil is as fierce and angry as that

Photo Underwood & Underwood

A Team of Thirty-three Horses Thrashing and Sacking Wheat at Walla-Walla, Washington

between the warring races of mankind, and the results are similar. As the triumphs of barbarism rendered Europe of old waste and ruin, so that the wild boar roamed where Rome, mistress of the world, had built her cities and dedicated seats to learning, so the conquest of man's friendly allies in this grain of soil is followed by conditions in which the soils grows sick and sterile, and can no longer produce fruits for the service of humanity. The analogy may seem strained, but the fact is indisputable.

Elaborate investigations at the world-famous Rothamstead Agricultural Experimental Station show that the fecundity of the land depends upon the issue of the battle between benevolent bacteria and malignant. The contest is continuous in our fields and gardens, but it exists in its intensest form under artificial conditions in our greenhouses. All our tomatoes, cucumbers, grapes, melons, the bulk of our peaches, nectarines, and apricots; all our winter flowers—chrysanthemums, tulips, lilies, ferns, and early strawberries at thirty shillings per pound—are grown under glass, and the industry represents almost incredible capital. One grower alone produces a million to two million tulips a year for Covent Garden. Now in the unnatural winter heat of the glasshouses, bacterial life multiplies enormously, and it is found that the malignant forms wax strong and numerous beyond computation at the expense of the benevolent, with the result that one crop of cucumbers, for example, completely exhausts the soil in which they are grown. The soil has to be thrown away at the end of the year as useless, sterile as the sands of the Sahara. To obtain new soil in the great nursery area around London is an increasingly pressing problem.

Photo S. I. Barton

A Fifty-Guinea Daffodil

By the expenditure of extraordinary pains and ingenuity, flowers, like soil, can be changed in character. Bulbs of the pure white variety here shown (developed from the ordinary coloured variety) have sold for fifty guineas each

But now the soil-doctor makes his appearance, and treats the earth as the physician treats his human patient, or as the great steel manufacturer treats his ores. The latter purifies his steel of an unknown quantity of carbon, then puts back a known quantity. The soil doctor may do pretty much the same thing. It has been discovered at Rothamstead that by a sterilising process old soil may be rendered fertile as new. This is accomplished in one of several ways. The specialist uses chloroform or toluole, or calcium sulphide, phenol, petrol, or other agencies. Or he puts his soil in an iron retort and bakes it, or forces steam through it, so that its temperature is raised to boiling point. The effect is to destroy the deleterious bacteria and leave the serviceable free to multiply. It is not clear whether any of the benevolent survive the sterilising process, or whether the new stock arises from their surviving spores, or whether the sterilised soil, on being released from its ordeal, is colonised afresh.

But there is no uncertainty as to the effect. Exhausted soil proves, after treatment, more fertile than soil of the best kind which has not been treated. Soil, thrown away as valueless, becomes, like the dump-heaps of the radium-yielding mines of Austria and Cornwall, precious as gold.